Contra Costa local stormwater ordinances require:

"Every application for a development project, including but not limited to a rezoning, tentative map, parcel map, conditional use permit, variance, site development permit, design review, or building permit that is subject to the development runoff requirements in the […] NPDES permit shall be accompanied by a Stormwater Control Plan that meets the criteria in the most recent version of the Contra Costa Clean Water Program *Stormwater C. 3. Guidebook.*"

CONTRA COSTA CLEAN WATER PROGRAM

Stormwater Quality Requirements for Development Applications

Stormwater C.3 Guidebook

THIRD EDITION—OCTOBER 2006

Visit www.cccleanwater.org/construction/nd.php for updates

Stormwater C.3 Guidebook

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Glossary

Best Management Practice (BMP)	Any procedure or device designed to minimize the quantity of pollutants that enter the storm drain system. See Chapter Two for a discussion of the various types of BMPs.
C.3	Provision, added in February 2003, of the San Francisco Bay Regional Water Quality Control Board's (see definition) stormwater NPDES permit (see definition). Requires each Discharger (see definition) to change its development review process to control the flow of stormwater and stormwater pollutants from new development sites. Order R2-2003-0022.
C.3 Web Page	www.cccleanwater.org/nd.php
California Association of Stormwater Quality Agencies (CASQA)	Publisher of the California Stormwater Best Management Practices Handbooks, available at www.cabmphandbooks.com. Successor to the Storm Water Quality Task Force (SWQTF).
California BMP Method	A method for determining the required volume of stormwater treatment facilities. Described in Section 5.5.1 of the California Stormwater Best Management Practice Manual (New Development) (CASQA, 2003).
Compensatory Mitigation	Treatment of an equivalent pollutant loading or quantity of stormwater runoff or other equivalent water quality benefit, created where no other requirement for treatment exists, in lieu of on-site treatment facilities.
Conditions of Approval (COAs)	Requirements a municipality may adopt for a project in connection with a discretionary action (e.g., adoption of an EIR or negative declaration or issuance of a use permit). COAs may include features to be incorporated into the final plans for the project and may also specify uses, activities, and operational measures that must be observed over the life of the project.
Contra Costa Clean Water Program (CCCWP)	CCCWP is established by an agreement among 19 Contra Costa cities and towns, Contra Costa County, and the Contra Costa County Flood and Water Conservation District. See list under Dischargers. CCCWP implements common tasks and assists the member agencies to implement their local stormwater pollution prevention programs.
Design Storm	A synthetic rainstorm defined by rainfall intensities and durations. See "Stormwater Hydrology" in Chapter Two.
Detention	The practice of holding stormwater runoff in ponds, vaults, within berms, or in depressed areas and letting it discharge slowly to the storm drain system. See definitions of infiltration and retention.

Directly Connected Impervious Area — Any impervious surface which drains into a catch basin, area drain, or other conveyance structure without first allowing flow across pervious areas (e.g. lawns).

Direct Infiltration — Infiltration via methods or devices, such as dry wells or infiltration trenches, designed to bypass unsaturated surface soils and transmit runoff directly to groundwater.

Dischargers — The agencies named in the stormwater NPDES permit (see definition): Contra Costa County, Contra Costa County Flood Control and Water Conservation District, City of Clayton, City of Concord, Town of Danville, City of El Cerrito, City of Hercules, City of Lafayette, City of Martinez, Town of Moraga, City of Orinda, City of Pinole, City of Pittsburg, City of Pleasant Hill, City of Richmond, City of San Pablo, City of San Ramon, and City of Walnut Creek. In addition, three Contra Costa cities within the jurisdiction of the Central Valley Regional Water Quality Control Board have agreed to implement C.3 provisions under the same schedule: City of Antioch, City of Brentwood, and City of Oakley.

Drawdown time — The time required for a stormwater detention or infiltration facility to drain and return to the dry-weather condition. For detention facilities, drawdown time is a function of basin volume and outlet orifice size. For infiltration facilities, drawdown time is a function of basin volume and infiltration rate.

Exemption — Exemption from the requirement to provide compensatory mitigation may be allowed for projects that meet certain criteria set by the RWQCB. These projects must, however, show impracticability (see definition of impracticable) of on-site treatment facilities and also show that the costs of compensatory mitigation would place an "undue burden" on the project.

Flow Control — Control of runoff rates and durations as required by the CCCWP's Hydrograph Modification Management Plan.

Group 1 Project — As described in NPDES Permit Provision C.3.c., a development project which creates or replaces an acre or more of impervious area.

Group 2 Project — As described in NPDES Permit Provision C.3.c., a development project which creates or replaces between 10,000 square feet and one acre of impervious area.

Head — In hydraulics, energy represented as a difference in elevation. In slow-flowing open systems, the difference in water surface elevation, e.g., between an inlet and outlet.

Hydrograph — Runoff flow rate plotted as a function of time.

Hydrograph Modification Management Plan (HMP)	As required by Provision C.3 provisions of the Stormwater NPDES permit, a draft HMP was submitted to the Regional Water Board November 15, 2004 and a final HMP submitted by May 15, 2005. The HMP was approved by the Regional Water Board in July 2006 and will be implemented so that post-project runoff from Group 1 Projects shall not exceed estimated pre-project rates and/or durations, where increased runoff would result in increased potential for erosion or other adverse impacts to beneficial uses. Also see definition for flow control.
Hydrologic Soil Group	Classification of soils by the Natural Resources Conservation Service (NRCS) into A, B, C, and D groups according to infiltration capacity. See Appendix C.
Impervious surface	Any material that prevents or substantially reduces infiltration of water into the soil. See discussion of imperviousness in Chapter Two.
Impracticable	As applied to on-site treatment facilities, technically infeasible (see definition) or excessively costly, as demonstrated by set criteria.
Infeasible	As applied to on-site treatment facilities, impossible to implement because of technical constraints specific to the site.
Indirect Infiltration	Infiltration via facilities, such as swales and bioretention areas, expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly or may be underdrained through subsurface pipes.
Infiltration	Seepage of runoff through the soil to mix with groundwater. See definition of retention.
Infiltration Device	Any structure that is designed to infiltrate stormwater into the subsurface and, as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil. See definition for direct infiltration.
Integrated Management Practice (IMP)	A facility (BMP) that provides small-scale treatment, retention, or detention and is integrated into site layout, landscaping and drainage design. See Low Impact Development.
Integrated Pest Management (IPM)	An approach to pest management that relies on information about the life cycles of pests and their interaction with the environment. Pest control methods are applied with the most economical means and with the least possible hazard to people, property, and the environment.
Intensity-duration-frequency (IDF)	An adjunct to the rational method (see definition), IDF allows calculation of the governing rainfall intensity based on the estimated time required for runoff flows from the farthest point of a drainage area to reach the point where peak flows are to be determined.

Lead Agency
The public agency that has the principal responsibility for carrying out or approving a project. (CEQA Guidelines §15367).

Low Impact Development
An integrated site design methodology that uses small-scale detention and retention (Integrated Management Practices, or IMPs) to replicate pre-existing site hydrological conditions.

Maximum Extent Practicable (MEP)
Standard, established by the 1987 amendments to the Clean Water Act, for the implementation of municipal stormwater pollution prevention programs (see definition). Also see Chapter Two.

National Pollutant Discharge Elimination System (NPDES)
As part of the 1972 Clean Water Act, Congress established the NPDES permitting system to regulate the discharge of pollutants from municipal sanitary sewers and industries. The NPDES was expanded in 1987 to incorporate permits for stormwater discharges as well.

Nomograph
A chart that aids engineering calculations by representing the relationship among three variables. Nomographs in the California BMP Handbooks represent the relationship among percent annual capture, watershed imperviousness, and unit water quality volume.

Numeric Criteria
Sizing requirements for stormwater treatment facilities established in Provision C.3.d. of the RWQCB's stormwater NPDES permit.

Operation and Maintenance (O&M)
Refers to requirements in the Stormwater NPDES Permit to inspect treatment BMPs and implement preventative and corrective maintenance in perpetuity. See Chapter Six.

Permeable Pavements
Pavements for roadways, sidewalks, or plazas that are designed to infiltrate runoff, including pervious concrete, pervious asphalt, unit-pavers-on-sand, and crushed gravel.

Percentile Rainfall Intensity
A method of determining design rainfall intensity. Storms occurring over a long period are ranked by rainfall intensity. The storm corresponding to a given percentile yields the design rainfall intensity.

Planned Unit Development (PUD)
Allows land to be developed in a manner that does not conform to existing zoning requirements. Allows greater flexibility and innovation because the PUD is regulated as one unit rather than each component lot being regulated separately.

Rational Method
A method of calculating runoff flows based on rainfall intensity, and tributary area, and a factor representing the proportion of rainfall that runs off.

Regional (or Watershed) Stormwater Treatment Facility
A facility that treats runoff from more than one project or parcel. Participation in a regional facility may be in lieu of on-site treatment controls, subject to the requirements of NPDES permit provision C.3.g.

Regional Water Quality Control Board (Regional Water Board or RWQCB)	California RWQCBs are responsible for implementing pollution control provisions of the Clean Water Act and California Water Code within their jurisdiction. There are nine California RWQCBs. Western and central Contra Costa County are under the jurisdiction of the RWQCB for the San Francisco Bay Region; eastern Contra Costa County is under the jurisdiction of the RWQCB for the Central Valley Region.
Retention	The practice of holding stormwater in ponds or basins and allowing it to slowly infiltrate to groundwater. Some portion will evaporate. See definitions for infiltration and detention.
Self-retaining area	An area designed to retain runoff. Self-retaining areas may include graded depressions with landscaping or pervious pavements and may also include tributary impervious areas up to a 2:1 impervious-to-pervious ratio (1:1 for projects subject to flow-control requirements).
Source Control	A facility or procedure intended to prevent pollutants from entering runoff.
Stormwater Control Plan	A plan specifying and documenting permanent site features, BMPs, and facilities designed to control pollutants for the life of the project.
Stormwater Control Operation & Maintenance Plan	A plan detailing operation and maintenance requirements for stormwater treatment BMPs incorporated into a project. An acceptable Stormwater Control Operation and Maintenance Plan must be submitted before the building permit is made final and a Certificate of Occupancy is issued.
Stormwater NPDES Permit	A permit issued by a Regional Water Quality Control Board (see definition) to local government agencies (Dischargers) placing provisions on allowable discharges of municipal stormwater to waters of the state.
Storm Water Pollution Prevention Plan (SWPPP)	A plan providing for temporary measures to control sediment and other pollutants during construction.
Stormwater Pollution Prevention Program	A comprehensive program of activities designed to minimize the quantity of pollutants entering storm drains. See Chapter One.
Storm Water Quality Task Force (SWQTF)	Publisher of the 1993 California Storm Water BMP Handbooks. See California Association of Stormwater Quality Agencies (CASQA).
Treatment	Removal of pollutants from runoff, typically by filtration or settling.
WEF Method	A method for determining the minimum design volume of stormwater treatment facilities, recommended by the Water Environment Federation and American Society of Civil Engineers. Described in *Urban Runoff Quality Management* (WEF/ASCE, 1998).

Water Board See Regional Water Quality Control Board.

Water Quality Volume (WQV) For stormwater treatment facilities that depend on detention to work, the volume of water that must be detained to achieve maximum extent practicable pollutant removal. This volume of water must be detained for a specified drawdown time.

Start

How to Use this Guidebook

Read the Overview to get a general understanding of the requirements. Then follow the step-by-step instructions to prepare your Stormwater Control Plan.

THIS *Guidebook* will help you ensure that your project complies with the California Regional Water Quality Control Boards' C.3 requirements. The requirements are complex and technical, and most applicants will require the assistance of a qualified civil engineer, architect, or landscape architect. Because every project is different, you should begin by scheduling a pre-application meeting with municipal planning staff.

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

To use the *Guidebook,* start by reviewing Chapter One, which provides a brief overview and explanation of the new requirements to control runoff from new development projects. The overview covers regulations, the plan review process, design issues, and the environmental benefits the regulations are intended to achieve. Chapter One will also help you determine which requirements apply to your project.

If there are terms and issues you find puzzling, try finding answers in the glossary or in Chapter Two. Chapter Two consists of one-page summaries of key concepts like "maximum extent practicable," "imperviousness," and "design storm."

Then proceed to Chapter Three and follow the step-by-step guidance to prepare a Stormwater Control Plan for your site.

If your project requires CEQA review, Chapter Four will tell you how to integrate analysis of stormwater impacts and mitigations into your documentation.

Design requirements are provided in Chapter Five, along with references that will aid you in designing the features you've identified in your Stormwater Control Plan. Chapter Five also includes a simplified procedure for sizing stormwater treatment and flow-control (hydrograph modification management) facilities.

Chapter Six describes the agreements—dedication of fee or easement, a maintenance agreement that "runs with the land," or other long-term commitment—to provide for operation and maintenance of stormwater treatment facilities in perpetuity. Chapter Six also outlines maintenance requirements for some recommended treatment and flow-control devices.

Chapter Seven discusses some options you may have for alternative (off-site) compliance with the Regional Water Quality Control Boards' C.3 requirements.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this county-wide Guidebook. See Appendix A for local requirements.

Throughout each Chapter, you'll find references and resources to help you understand the regulations, complete your Stormwater Control Plan, and design stormwater control measures for your project.

The most recent, updated version of the *Guidebook* is on the Contra Costa Clean Water Program website at www.cccleanwater.org/construction/nd.php. The on-line *Guidebook* is in Adobe Acrobat format. If you are reading the Acrobat version on a computer with an internet connection, you can use hyperlinks to navigate the document and to access various references. The hyperlinks are throughout the text, as well as in "References and Resources" sections (marked by the icon) and in the bibliography. Some of these links (URLs) may be outdated. In that case, try entering portions of the title or other keywords into an internet search engine.

► PLAN TO AVOID THE THREE MOST COMMON MISTAKES

The most common (and costly) errors made by applicants for development approvals with respect to C.3 compliance are:

1. Not planning for C.3 compliance early enough. You should think about your strategy for C.3 compliance before completing a conceptual site design or sketching a layout of subdivision lots (Chapter 3).

2. Assuming proprietary stormwater treatment facilities will be adequate for compliance. Most aren't (Chapter 5).

3. Not planning for periodic inspections and maintenance of treatment and flow-control facilities. Consider who will own and who will maintain the facilities in perpetuity and how they will obtain access, and identify which arrangements are acceptable to your municipality (Chapter 6).

Chapter 1

Overview

For a broad-based understanding, look at stormwater requirements from four different perspectives: as water-quality regulations, as planning requirements, as a design challenge, and as a way to obtain environmental benefits for the community.

State and Federal Regulatory Perspective

The California Regional Water Quality Control Boards for the San Francisco Bay Region and Central Valley Region (RWQCBs) have mandated Contra Costa municipalities impose new, more stringent requirements to treat runoff from new developments before the runoff is discharged to municipal storm drains. Some new developments must also control the rates and durations of runoff flows.

The RWQCBs added Provision C.3 to the municipalities' stormwater NPDES permit in February 2003. The municipalities are phasing in the requirements from 2004 through 2006.

The RWQCBs have determined the new Provision C.3 requirements are needed to implement Federal Clean Water Act provisions governing discharges to municipal storm drains.

Congress adopted amendments to the Clean Water Act in 1987, and the United States Environmental Protection Agency (USEPA) issued implementing regulations in 1990. The San Francisco Bay RWQCB began issuing stormwater discharge permits to municipalities that same year.

Clean Water Act
Regulations on stormwater discharges have grown progressively more stringent since the Clean Water Act was amended in 1987.

Since the early 1990s, Contra Costa municipalities have required contractors to implement temporary Best Management Practices (BMPs) to minimize the amount of sediment and other pollutants that enter site runoff during construction. Municipalities have also encouraged applicants to design their projects to minimize new impervious area and to incorporate into their plans permanent treatment and flow-control BMPs—facilities that detain, retain, or treat runoff for the life of the project.

"Maximum Extent Practicable"

For more on this and other stormwater terms, see the Glossary and discussions in Chapter Two.

As before, the standard for these permanent facilities is maximum extent practicable, or MEP. However, the new permit requirements define MEP for treatment and flow-control facilities more specifically—by including design criteria.

The new development provisions are one part of a comprehensive stormwater pollution prevention program implemented by each Contra Costa municipality. Those programs also require:

- Controls on runoff from existing commercial and industrial sites.
- Temporary measures to control sediment and other pollutants in runoff from construction sites.
- Changes in the way the municipalities maintain streets, parks and public infrastructure.
- Prevention of illegal dumping in storm drains.
- Public outreach and education.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Under the RWQCBs' stormwater discharge permits, cities, towns, and the County implement some activities individually. Other activities are done jointly through the Contra Costa Clean Water Program (CCCWP).

RWQCB staff monitors each municipality's implementation of permit requirements. Each municipality must report on its development review process, number and type of projects reviewed, and what runoff control measures were included in the projects.

References and Resources

- San Francisco Bay RWQCB Order No. 99-058 (Stormwater NPDES Permit)
- Central Valley RWQCB Order 5-00-120 (Stormwater NPDES Permit covering Antioch, Brentwood, and Oakley and eastern portions of unincorporated Contra Costa County)
- San Francisco Bay RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit C.3 Amendment)

- San Francisco Bay RWQCB Order No. R2-2006-0050 (revising flow-control (hydrograph modification management) requirements
- RWQCB Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan)
- RWQCB Water Quality Control Plan for the Central Valley Region (Basin Plan)
- Clean Water Act Section 402(p)
- 40 CFR 122.26(d)(2)(iv)(A)(2) – Stormwater Regulations for New Development
- CCCWP – Stormwater Management Plan (1999-2004)

Local Development Review Perspective

The Contra Costa Clean Water Program created this *Guidebook* to help project applicants implement the stormwater C.3 requirements. The C.3 requirements are the same in all Contra Costa municipalities; however, specific procedures and application requirements may differ somewhat from one municipality to the next. The staff of each municipality aims to make the complex C.3 requirements clear and easy to follow. Municipal staff will work with project applicants to facilitate timely and complete review of their projects.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

► THRESHOLDS AND START DATES

Table 1-1 summarizes applicability of the Provision C.3 requirements.

TABLE 1-1. Thresholds, Start Dates, and Requirements summarized.*

Threshold	*Start Date*	*Requirement*
Group 1: Commercial, industrial, or residential developments that create one acre or more of impervious surface, and projects on previously developed sites that result in addition or replacement, which combined, total an acre or more of impervious surface.	Development applications deemed complete February 15, 2005 or later but before October 14, 2006	Treatment and source control measures as specified in the NPDES permit and this *Guidebook*.
	Development applications deemed complete October 14, 2006 or later	Treatment and source control measures, plus runoff flow control so post-project runoff does not exceed estimated pre-project rates or durations. Demonstrate compliance using one of the four options described in Appendix D.
Group 2: Same as Group 1, but threshold reduced to 10,000 square feet impervious area.	Development applications deemed complete August 15, 2006 or later	Treatment and source control measures as specified in the NPDES permit and this *Guidebook*.

*Summary only. Applicability to and requirements for any particular project are determined by your municipality.

Projects on sites which have been previously developed may also need to retrofit drainage on all impervious areas of the entire site as a condition of approval for a project to improve a portion of the site. For sites creating or replacing a total amount of impervious area greater than the applicable Group 1 or Group 2 threshold (Table 1-1):

- If the new project results in an increase of, or replacement of, 50% or more of the previously existing impervious surface, and the existing development was not subject to stormwater treatment measures, then the entire project must be included in the treatment measure design.

- If less than 50% of the previously impervious surface is to be affected, only that portion must be included in the treatment measure design.

Interior remodels, routine maintenance or repair, roof or exterior surface replacement, and repaving are not subject to C.3 requirements.

► DEVELOPMENT REVIEW PROCESS

The process for reviewing stormwater controls is integrated with the municipalities' development review process. A simplified diagram of a typical development review process is shown in Figure 1-1.

If the C.3 requirements apply, planning staff will require that a complete Stormwater Control Plan be submitted along with the Planning and Zoning application.

In some cases, staff may request a preliminary site layout, preliminary landscaping plan, elevations, or illustrations for review. These preliminary plans should be coordinated with a conceptual plan for drainage, including preliminary location of stormwater treatment and flow-control facilities. This should be discussed at the pre-application meeting.

If the project requires review under the California Environmental Quality Act (CEQA), planning staff will require submittal of an Environmental Information Form. This submittal should document potential impacts of the project's changes to stormwater runoff. Typically, staff will use an initial study checklist to determine whether the project may still have significant effects on the environment after proposed mitigation measures are included. Stormwater impacts can be mitigated by minimizing site imperviousness, controlling pollutant sources, and incorporating treatment and flow-control facilities that retain, detain, or treat runoff.

CEQA

See Chapter Four for a discussion of how to document stormwater impacts and mitigations in Initial Studies and Environmental Impact Reports.

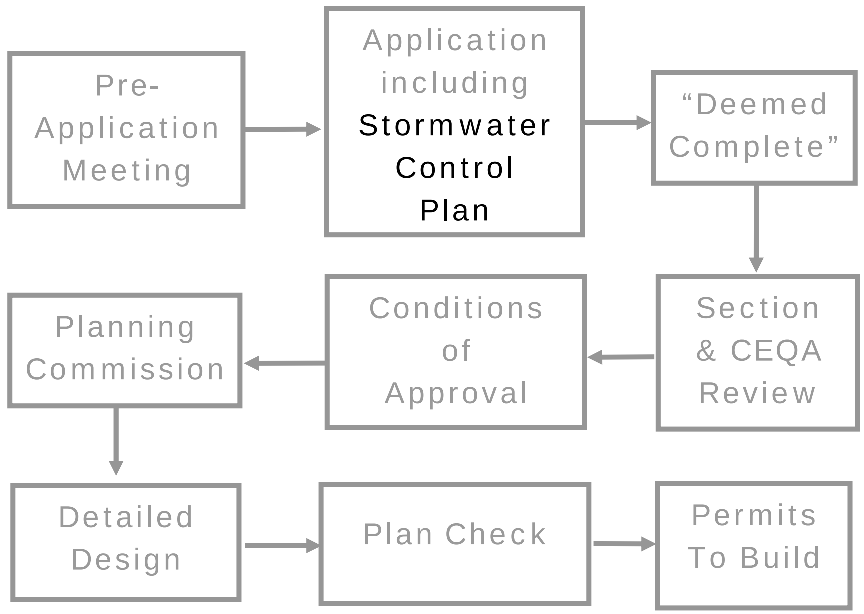


FIGURE 1-1. REVIEW OF THE STORMWATER CONTROL PLAN is integrated with the municipal development review process.

This *C.3 Guidebook* will assist you to prepare a Stormwater Control Plan for your project. Staff will use the checklist in Chapter 3 to determine if the stormwater control plan portion of your application is complete. Once the application is deemed complete, staff will use the *Guidebook* to determine whether the Stormwater Control Plan complies with the RWQCBs' C.3 requirements and their own local requirements.

Planning staff or the Planning Commission (or in some cases, a City Council or the County Board of Supervisors) will approve or deny the application. If the application is approved, staff, the commission, or the Council or Board will attach conditions of approval, including a requirement that you implement your Stormwater Control Plan. A typical standard condition of approval mandating Stormwater Control Plan implementation is in Appendix B.

Following approval of your planning and zoning application, you may submit your application for building permits. City staff will check that the features and devices specified in the Stormwater Control Plan are incorporated into the construction plans, that the stormwater controls meet specified design criteria, and that their construction will comply with applicable building codes. A stormwater treatment control operation and maintenance plan (described in Chapter 6) must be submitted and approved before the building permit can be made final and a certificate of occupancy issued.

Prepare the stormwater control plan simultaneously with the preliminary site plan and landscaping plan.

Doing so will:

- Maximize multiple benefits of site landscaping.
- Reduce overall project costs.
- Improve site aesthetics and produce a better quality project.
- Be more likely to achieve "maximum extent practicable."
- Speed project review.
- Avoid unnecessary redesign.

A Stormwater Control Plan is a separate document from the Storm Water Pollution Prevention Plan (SWPPP). See Table 1-2. The SWPPP provides for temporary measures to control sediment and other pollutants during construction at sites that disturb one acre or more. The Stormwater Control Plan specifies permanent controls that should last for the life of the project. In some cases, the two plans need to be coordinated. For example, at the end of the construction phase, a basin used for temporary sediment control could be converted to a permanent swale, basin, or bioretention area. The basin would be shown in both plans.

Preparing a Stormwater Control Plan involves the following steps:

1. Assemble needed information.
2. Identify constraints and opportunities.
3. Design to minimize imperviousness.
4. Locate and select treatment and flow-control facilities.
5. Perform preliminary design of facilities and document flow-control (HMP) compliance.
6. Specify source controls.
7. Integrate with other preliminary drawings.
8. Identify permitting and code compliance issues.
9. Identify facility maintenance requirements.

10. Complete a Stormwater Control Plan & Report.

Chapter Three helps guide you through each step. Chapter Four includes information on how to document stormwater potential impacts and mitigations in CEQA documentation.

► IMPLEMENTING C.3 ON PHASED PROJECTS

When determining whether Provision C.3 requirements apply, a "project" should be defined consistent with CEQA definitions of "project." That is, the "project" is the whole of an action which has the potential for adding or replacing, or resulting in the addition or replacement, of roofs, pavement, or other impervious surfaces and thereby resulting in increased flows and stormwater pollutants. "Whole of an action" means the project may not be segmented or piecemealed into small parts if the effect is to reduce the quantity of impervious area for any part to below the C.3 threshold.

Grandfathering. Municipalities may, at their discretion, exempt projects for which applications were deemed complete prior to the C.3 start dates (Table 1-1). However, this "grandfathering" applies only to the specific discretionary approval that was the subject of the pre-start-date application. Subsequent applications for further approvals constitute a "project" for the purposes of C.3. If those subsequent approvals or entitlements cover specific locations, modes, or designs for addition or replacement of roofs, pavement, or other impervious surfaces, and if the impervious area created or replaced is in excess of the applicable thresholds,

TABLE 1-2. A SWPPP and a Stormwater Control Plan are separate documents.

	Storm Water Pollution Prevention Plan (SWPPP)	*Stormwater Control Plan*
Primary objective	Minimize potential runoff pollution during construction.	Minimize potential runoff pollution and runoff flows for the life of the project.
Pollutants targeted	Sediment from erosion and site disturbance, maintenance of construction equipment, construction activities (e.g. painting).	Pollutants deposited in airborne dust, liquids and dust from automobiles, cleaning solutions (e.g. from food service), litter and trash.
Coordination with review process	Submitted with application for building permit.	Submitted with application for planning and zoning review.
Coordination with project planning	Coordinated with grading plans and construction scheduling and phasing.	Integrated with site plan, drainage plan, and landscaping.

then the C.3 requirements will apply to those areas of the project covered by the subsequent approval or entitlement.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Consider, for example, an application for a subdivision tentative map which was deemed complete prior to the C.3 start dates. The project would not need to implement the C.3 requirements; however, if the project proponent later applies for discretionary approval of specific locations, modes, or designs of paving and structures, then C.3 requirements would apply to those improvements.

Applying the "50% rule." As another example, consider an application for approval of a project on a portion of an already developed site. Does the new project create or replace more than 50% of the previously existing development and must, therefore, C.3 requirements also be applied to the portions of the previously existing development which are not affected by the project? Municipal staff will determine case-by-case when and how the "50% rule" applies; in doing so staff may use the original entitlement (discretionary approval) for the "previously existing development" as a guide.

Stormwater Control Plan requirements for phased projects. Municipal staff may require, as part of an application for approval of a phased development project, a conceptual or master Stormwater Control Plan which describes and illustrates, in broad outline, how the drainage for the project will comply with the Provision C.3 requirements. The level of detail in the conceptual or master Stormwater Control Plan should be consistent with the scope and level of detail of the development approval being considered. The conceptual or master Stormwater Control Plan should specify that a more detailed Stormwater Control Plan for each later phase or portion of the project will be submitted with subsequent applications for discretionary approvals.

Note these minimum standards for C.3 applicability are for the purpose of ensuring a consistent minimum level or "floor" for countywide implementation consistent with the requirements of the NPDES permit. Individual municipalities may choose a more expansive interpretation of the NPDES permit's applicability, and may also choose to apply the C.3 source control, treatment, and flow-control requirements to projects that would be exempt under these minimum standards.

► APPLYING C.3 TO NEW SUBDIVISIONS

If a tentative map approval would potentially entitle future owners to construct new or replaced impervious area which, in aggregate, could exceed of the thresholds (Table 1-1), then the applicant must take steps to ensure C.3 requirements can and will be implemented as the project is built out.

See the *Policy for C.3 Compliance for Subdivisions* on the Contra Costa Clean Water Program's C.3 web page.

After consulting with local planning staff, applicants for subdivision approvals will propose one of the following four options, depending on project characteristics and local policies:

1. Show the sum of future impervious areas to be created on all parcels could not exceed the threshold.

2. Show that, for each and every lot, the intended use can be achieved with a design which disperses runoff from roofs, driveways, streets, and other impervious areas to adjacent pervious areas, using the criteria in this *Guidebook*.

3. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook,* and commit to constructing the facilities and providing for their maintenance.

4. Prepare improvement plans showing drainage to treatment and/or flow-control facilities designed in accordance with this *Guidebook*, and provide appropriate legal instruments to ensure the proposed facilities will be constructed and maintained by subsequent owners.

For the option selected, municipal staff will determine the appropriate conditions of approval, easements, deed restrictions, or other legal instruments necessary to assure future compliance.

► COMPLIANCE WITH FLOW-CONTROL REQUIREMENTS

All applications for development approvals for Group 1 and Group 2 projects (see Table 1-1 on page 5) must be accompanied by a Stormwater Control Plan detailing how stormwater source control and treatment requirements will be implemented. As shown in Table 1-1, some projects must also provide flow control so post-project runoff does not exceed estimated pre-project rates and durations.

Projects subject to flow-control requirements have four options for demonstrating compliance. The options are summarized in Table 1-3. Detailed requirements are in Appendix D.

As shown in Table 1-1, all developments subject to the flow-control requirements are also subject to the treatment requirements. Most applicants will find it easiest—and most cost-effective—to use the Contra Costa Clean Water Program's sizing tool to select and design Integrated Management Practices (IMPs) to meet

TABLE 1-3. Options for compliance with flow-control requirements*

What must be demonstrated	*How applicants can comply*	*Stormwater Control Plan submittal requirements*
Option 1: No increase in impervious area	Compare the project design to the pre-project condition and show the project will not increase impervious area and also will not increase efficiency of drainage collection and conveyance.	Inventory and accounting of existing and proposed impervious areas, measures used to reduce imperviousness, and a qualitative comparison of pre- and post-project drainage efficiency.
Option 2: Integrated Management Practices	Use the design procedure and design criteria in this *Guidebook*, and the Program's sizing tool, to select and size IMPs (also meets treatment requirements).	Stormwater Control Plan and sizing tool output (Chapter 3).
Option 3: Post-project runoff does not exceed pre-project rates and durations	Use a continuous-simulation model and 30 years or more of hourly rainfall data to simulate pre-project and post-project runoff, including the effect of proposed control facilities.	Model parameters and modeling techniques are specified in Appendix D.
Option 4a: All downstream reaches are at "low risk" of erosion	Show all downstream channels between the project site and the Bay/Delta are enclosed pipes, are engineered hardened channels, are subject to tidal action, or are aggrading.	Report or letter report by an engineer or qualified environmental professional documenting drainage between the project site and the Bay or Delta.
Options 4b and 4c: Erosion risks are mitigated by in-stream restoration projects	Propose and implement appropriate in-stream restoration projects to fully mitigate potential risk.	Requires additional regulatory approvals. See Appendix D.

*Summary only. Applicability to and requirements for any particular project are determined by your municipality.

both treatment and flow-control requirements (Option 2).

Depending on location and existing site conditions, a project proponent may be able to demonstrate flow-control compliance by:

- Showing the project will not increase the existing quantity of impervious area and will not facilitate the efficiency of drainage collection and conveyance (Option 1), or

- Showing that all downstream channels between the project site and the Bay/Delta are enclosed pipes, are engineered hardened channels, are subject to tidal action, or are aggrading (Option 4a).

The treatment requirements still apply, regardless of location or existing site condition.

Applicants designing larger developments, particularly those with complex or extensive drainage, might consider creating a continuous hydrologic simulation model, using the criteria in Appendix D, to demonstrate post-project runoff will not exceed pre-project rates or durations (Option 3).

Under Options 4b and 4c, applicants may propose and implement an appropriate in-stream restoration project to fully mitigate the potential risk of increased downstream erosion created by their proposed development.

References and Resources:

- Appendix D
- RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit Amendments) Provisions C.3.(b) and C.3.(j)
- RWQCB Order No. R2-2006-0050, revising hydrograph modification management (flow-control) requirements
- CCCWP Policy for C.3 Compliance for Subdivisions
- California Planning and Zoning Law
- California Environmental Quality Act
- *CEQA Deskbook 1999 [Second] Edition* (Bass, Herson, and Bogdan, Solano Press Books, 2001)
- California Building Code
- *California Stormwater Best Management Practice Handbook (Construction)*
- *Manual of Standards for Erosion and Sediment Control Measures* (Association of Bay Area Governments, 1986)

Planning and Design Perspective

In most cases, stormwater controls will add to the overall cost of a project. Stormwater controls may also constrain use of the site.

However, if executed well, and if integrated with landscaping and site amenities, stormwater controls can add to your project's quality and value.

From a site design perspective, the aim of stormwater controls is to make site drainage mimic, as much as possible, the way a natural landscape drains.

Much of the rain falling on a natural landscape is held by vegetation, soaks into the soil, or seeps slowly downhill. Pollutants washed out from the atmosphere are absorbed through contact with soils and vegetation.

Roofs and paving prevent rain from reaching the soil. Pollutants wash off the impervious surfaces, and drain pipes transport the runoff rapidly and efficiently to creeks or the Bay. Higher peak flows and runoff volumes may promote channel erosion—unless streambanks are hardened.

An obvious, and effective, way to limit site runoff is to minimize the amount of pavement and roofs. Some paved areas can be designed with unit pavers, gravel, or other pervious surfaces. Runoff from small paved areas, like sidewalk or driveway strips, can be sloped to drain to concave lawns or landscaping.

Runoff collected from larger impervious areas, like roofs or parking lots, can be channeled through features located in depressions and integrated into the landscape. These features include swales, infiltration/detention basins, and bioretention areas.

These integrated management practices (IMPs) can help infiltrate runoff into the soil. If soils are impermeable or groundwater is too close to the surface—as in parts of Contra Costa County—the features can be equipped with an underdrain so that they detain and treat runoff before it is allowed to slowly drain away.

Where space and site layout do not allow swales, basins, or bioretention areas, it is still possible to use vaults for storage and sand filters for treatment. These devices work, but are more expensive, require more maintenance, do not contribute to site aesthetics, and (if not carefully maintained) can provide breeding habitat for mosquitoes.

Chapter Five provides guidance on design requirements.

References and Resources

- *Start at the Source* (BASMAA, 1999)
- California Best Management Practice Handbooks (CASQA, 2003).
- Urban Runoff Quality Management (WEF/ASCE, 1998)
- Low Impact Development Design Strategies: An Integrated Approach (Maryland, 2001)
- Site Planning for Urban Stream Protection (Scheuler, 1995)
- *Urban Small Sites Best Management Practice Manual* Barr Engineering for Metropolitan Council of Governments (Minneapolis/St. Paul)

Environmental Benefit Perspective

The diverse natural geography of Contra Costa County includes tidal and freshwater wetlands, alluvial plains, and mountain slopes. Annual rainfall varies from 12.5 inches in Brentwood to 30 inches in Orinda.

The climate, soils, slope, and vegetation give each Contra Costa stream a characteristic structure of riffles, pools, terraces, floodplains, and wetlands. In relatively undisturbed stream reaches, this geomorphic structure supports trees and other riparian vegetation. Trees provide shade (cooling stream temperatures), create root wads and undercut banks (refuge for fish) and produce falling leaves and detritus (the bottom of a food web). Fish, frogs, and other animals have evolved to thrive in riparian habitats. Because Contra Costa habitats are diverse and complex, some species are specialized, have limited ranges, and may be rare.

Contra Costa's landscape, like that of all the San Francisco Bay Area, has been repeatedly transformed since the Spanish arrived in the 1770s. Even before the area was developed, European grasses, weeds, and other plants replaced much of the native vegetation. Creek flows were diverted to irrigate farms, and wetlands were diked or filled for farmland.

Suburbs and former farm towns developed rapidly during and after the Second World War. In many places, to make flood-prone land suitable for development, creeks were channelized or confined within levees. Buildings, streets, and pavement now cover much of the land, and storm drains pipe runoff from urban neighborhoods directly into the creeks. Urbanization has changed the timing and intensity of stream flows and has set off a chain of unanticipated consequences. These consequences include more frequent flooding, destabilized stream banks, armoring of streambanks with riprap and concrete, loss of streamside trees and vegetation, and the destruction of stream habitat.

The remaining habitat, even where it has been disturbed and reduced to remnants, is an important refuge for various species. The U.S. and California have listed some of these species, including steelhead (*Oncorhyncus mykiss),* as endangered. Other species are listed as threatened, rare, or having other special status.

Once altered, natural streams and their ecosystems cannot be fully restored. However, it is possible to stop, and partially reverse, the trend of declining habitat and preserve some ecosystem values for the benefit of future generations.

This is an enormous, long-term effort. Managing runoff from a single development site may seem inconsequential, but by changing the way most sites are developed (and redeveloped), we may be able to preserve and enhance existing stream ecosystems in urban and urbanizing areas.

References and Resources

- *Restoring Streams in Cities* (Riley, 1998)
- *Stream Restoration: Principles, Processes, and Practices*
  (Federal Interagency Stream Restoration Working Group, 1998, revised 2001)
- *Contra Costa County Watershed Atlas* (Contra Costa County, 2003)

Chapter

2

Stormwater Concepts

All about BMPs, MEP, imperviousness, etc.

Like practitioners in any other specialized field, planners and engineers working on stormwater control have created their own lingo. Within the array of acronyms and shorthand, there are several key concepts—some of them based on water-quality regulations, others on evolved design practice—that are indispensable to communication between project proponents, designers, and reviewers.

The glossary at the front of this Guidebook lists words and concepts that can be explained adequately in a sentence or two. Other concepts require elaboration, including an explanation of how they apply to designing and permitting development projects.

This chapter explains the following key concepts:

- Maximum Extent Practicable
- Best Management Practices
- Imperviousness
- Design Storm

Maximum Extent Practicable

As required by the Clean Water Act, the RWQCB limits the allowable concentration (and sometimes the allowable load) of pollutants in municipal and industrial sewage discharged to State waters.

When it amended the Clean Water Act in 1987, Congress recognized that it was not technically feasible to establish similar limits on pollutants in stormwater discharged from municipal storm drains. Instead, Clean Water Act Section 402(p)(3)(iii) says that each state:

> …shall require controls to reduce the discharge of pollutants to the maximum extent practicable, including management practices, control techniques and system, design and engineering methods, and such other provisions as the Administrator or the State determines appropriate for the control of such pollutants.

"Maximum extent practicable" is not defined in Federal law or regulation.

CCCWP's Stormwater Management Plan incorporates continuous improvement to ensure that the pollution-prevention efforts consistently achieve "maximum extent practicable." Under the stormwater discharge permit, CCCWP updates performance standards that establish, for various elements of the stormwater pollution prevention program, the level of effort that currently corresponds to "maximum extent practicable."

When reviewing proposed development projects, municipal staff uses current performance standards and best professional judgment to determine whether proposed stormwater controls meet the "maximum extent practicable."

As knowledge of stormwater control develops, it is becoming more common for "maximum extent practicable" to be expressed as numeric criteria. For example, the 2003 C.3 amendments to the stormwater permit established numeric standards for sizing stormwater treatment facilities. Another amendment in 2006 added numeric standards for flow-control facilities. Municipal staff must apply these standards when reviewing proposed development projects.

For other aspects of site design and treatment facility design, municipal staff may consult available design manuals and apply their engineering or other professional judgment to determine "maximum extent practicable."

Best Management Practices

Clean Water Act Section 402(p) and USEPA regulations (40 CFR 122.26) specify a municipal program of "management practices" to control stormwater pollutants. Best Management Practice (BMP) refers to any kind of procedure or device designed to minimize the quantity of pollutants that enter the storm drain system.

Since the adoption of the regulations in 1990, a rough taxonomy of BMPs has emerged. As shown in Table 2-1, BMPs can be classified three ways:

A. *Manifestation*. Structural BMPs are built devices or site features (e.g., a roofed dumpster area or a constructed wetland). Operational BMPs are practices or procedures (e.g., dumping washwater in an indoor sink rather than the gutter, or sweeping outside work areas daily).

B. *Longevity*. Permanent BMPs are structural BMPs intended to last the life of the project (e.g. a constructed wetland). Temporary BMPs (e.g. silt fences) are removed when construction is finished.

C. *Mode*. Source control BMPs (or source control measures) aim to stop pollutants from entering stormwater. All operational BMPs are for source control, but source control BMPs can also be permanent structural BMPs (e.g., a berm around a dumpster area). Treatment BMPs are facilities that remove pollutants that have already become suspended or dissolved in stormwater.

TABLE 2-1. BMPs classified three ways.

A. Manifestation	*B. Longevity*	*C. Mode*
Structural	Permanent	Source Control
Operational	Temporary	Treatment

To reduce confusion, this Guidebook Third Edition uses the term "treatment facilities" to refer to structural, permanent, treatment BMPs.

As described in Chapter Three and Chapter Five, there are two approaches to incorporating treatment facilities into new development sites. Treatment facilities can be integrated into the landscape design and distributed throughout the site (Integrated Management Practices, or IMPs), or site drainage can be piped to a larger, engineered conventional facility (treatment BMP). Both IMPs and conventional facilities can be designed to control runoff rates and durations as well as provide stormwater treatment and are then referred to as treatment and flow-control facilities.

Commercial and industrial facilities must implement operational BMPs to the maximum extent practicable, and residents are expected to avoid allowing anything other than stormwater (e.g., soapy water, paint, litter) from entering storm drains. These requirements are implemented and enforced by other parts of municipal comprehensive stormwater pollution prevention programs.

Imperviousness

Schueler (1995) proposed imperviousness as a "unifying theme" for the efforts of planners, engineers, landscape architects, scientists, and local officials concerned with urban watershed protection. Schueler argued (1) that imperviousness is a useful indicator linking urban land development to the degradation of aquatic ecosystems, and (2) imperviousness can be quantified, managed, and controlled during land development.

Imperviousness has long been understood as the key variable in urban hydrology. Peak runoff flow and total runoff volume from small urban catchments is usually calculated as a function of the ratio of impervious area to total area (rational method). The ratio correlates to the runoff factor, usually designated "C". Increased flows resulting from urban development tend to increase the frequency of small-scale flooding downstream.

Imperviousness links urban land development to degradation of aquatic ecosystems in two principal ways.

First, the combination of paved surfaces and piped runoff efficiently collects urban pollutants and transports them, in suspended or dissolved form, to surface waters. These pollutants may originate as airborne dust, be washed from the atmosphere during rains, or may be generated by automobiles and outdoor work activities.

Second, increased peak flows and runoff durations typically cause erosion of stream banks and beds, transport of fine sediments, and disruption of aquatic habitat. Measures taken to control stream erosion, such as hardening banks with riprap or concrete, may permanently eliminate habitat. By reducing groundwater infiltration, imperviousness may also reduce dry-weather stream flows.

Imperviousness has two major components: rooftops and transportation (including streets, highways, and parking areas). The transportation component is usually larger and is more likely to be directly connected to the storm drain system.

The effects of imperviousness can be mitigated by disconnecting impervious areas from the drainage system and by making drainage less efficient—i.e., by encouraging detention and retention of runoff near the point where it is generated. Detention and retention reduce peak flows and volumes and allow pollutants to settle out or adhere to soils before they can be transported downstream.

Design Storm—Hydrology for NPDES Compliance

No two rainstorms are exactly alike. Hydrologists sort and analyze rain gauge records to find long-term patterns of rainfall intensity and duration. Then they estimate runoff flows and volumes based on these patterns and on the size, topography, soils, land uses, and drainage patterns of a particular watershed.

Engineers typically use a design storm to calculate the required size of facilities that convey, store, or treat runoff. Because small storms occur many times a year, and larger storms come once in many years, design storms are identified with the the probability of a storm with particular magnitude and duration occurring in any given year.

Different design storms apply to different purposes. Selection of a design storm balances project costs against risks of flood damages. Large flood control channels are typically designed to convey runoff from storms with a one-in-one-hundred (1%) probability of occurring in any particular year (commonly called the "one-hundred-year storm"). Flood-control detention basins are typically designed to attenuate flows from storms predicted to occur in 4% or 10% of the coming years (a 25-year or 10-year storm, respectively), depending on the watershed size, and to safely pass 100-year storm flows without catastrophic failure.

Rather than specifying a design storm, NPDES permit criteria for treatment facilities target treatment of 80% of average annual runoff. (See the discussion of maximum extent practicable on page 18.) A large portion of annual runoff is produced by small storms that occur many times a year. To achieve treatment of 80% of average annual runoff, treatment facilities can be sized to treat smaller, more frequent storms and therefore can be considerably smaller than flood-control facilities.

To develop local sizing criteria for stormwater treatment facilities, CCCWP consultants used hourly rainfall data from Contra Costa gauges and continuously simulated runoff over 30 years. The minimum basin size achieves detention and settling—for at least 48 hours—of 80% of the total runoff during the simulation period. (See Chapter 5 and Appendix H.)

For projects subject to flow-control requirements (Table 1-1), runoff must not exceed pre-project peak flows and durations. To prepare CCCWP's Hydrograph Modification Management Plan (HMP), consultants used 30 years of hourly rainfall data to simulate runoff from a hypothetical 1-acre site in (1) undeveloped and (2) completely impervious conditions. Then, using an iterative procedure, CCCWP consultants found the minimum size of facilities (IMPs) that, when built into the impervious site, would match the frequency and intensity of pre-project flows during the simulation period.

Chapter 3

Preparing Your Stormwater Control Plan

Step-by-step assistance for site design and BMP selection.

Begin by scheduling a pre-application meeting with municipal planning staff to identify and discuss specific requirements that may apply to your project. Prepare your Stormwater Control Plan for submittal along with the other items specified by planning staff.

► OBJECTIVES.

Your Stormwater Control Plan must demonstrate that your project will incorporate site design characteristics, landscape features, and engineered facilities that will minimize imperviousness, retain or detain stormwater, slow runoff rates, and reduce pollutants in post-development runoff to the maximum extent practicable. Additional requirements may apply if runoff from your site discharges directly to creeks or wetlands. (See Order R2-2003-0022, Provision C.3.b.ii).

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

A complete and thorough Stormwater Control Plan will enable planning staff to verify your project complies with these requirements. Every Contra Costa municipality requires a Stormwater Control Plan for every applicable project so municipal staff can document the project complies with the RWQCB permits.

► CONTENTS.

Your Stormwater Control Plan will consist of a report and an exhibit. Staff will use the following checklist to evaluate the completeness of your Plan.

STORMWATER CONTROL PLAN CHECKLIST

CONTENTS OF EXHIBIT

Show on drawings:

- ❐ Existing natural hydrologic features (depressions, watercourses, relatively undisturbed areas) and significant natural resources. (Step 1 in the following step-by-step instructions)
- ❐ Soil types and depth to groundwater. (Step 1)
- ❐ Existing and proposed site drainage network and connections to drainage off-site. (Step 3)
- ❐ Proposed design features and surface treatments used to minimize imperviousness. (Steps 3 and 4)
- ❐ Entire site divided into separate drainage areas, with each area identified as self-retaining (zero-discharge), self-treating, or draining to a treatment/flow control facility. (Steps 3, 4, and 5)
- ❐ For each drainage area, types of impervious area proposed (roof, plaza/sidewalk, and streets/parking) and area of each. (Steps 3, 4, and 5)
- ❐ Proposed locations and sizes of infiltration, treatment, or flow-control facilities. (Steps 4 and 5)
- ❐ Potential pollutant source areas, including loading docks, food service areas, refuse areas, outdoor processes and storage, vehicle cleaning, repair or maintenance, fuel dispensing, equipment washing, etc. listed in Appendix E and corresponding required source controls from Appendix E. (Step 6)

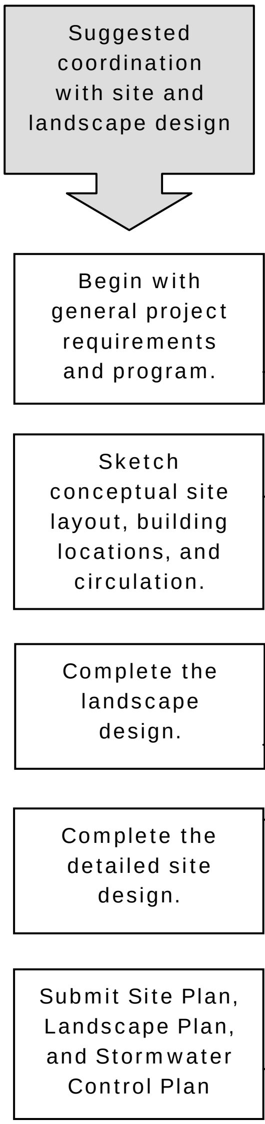
CONTENTS OF REPORT

Include in a report:

- ❐ Narrative analysis or description of site features and conditions that constrain, or provide opportunities for, stormwater control. (Step 2)
- ❐ Narrative description of site design characteristics that protect natural resources. (Step 3)
- ❐ Narrative description and/or tabulation of site design characteristics, building features, and pavement selections that reduce imperviousness of the site. (Step 3)
- ❐ Tabulation of proposed pervious and impervious area, showing self-treating areas, self-retaining areas, and areas tributary to each infiltration, treatment, or flow-control facility. (Steps 3, 4, and 5)
- ❐ Preliminary designs, including calculations, for each infiltration, treatment, or flow-control facility. Elevations should show sufficient hydraulic head for each. (Step 5)
- ❐ A table of identified pollutant sources and for each source, the source control measure(s) used to reduce pollutants to the maximum extent practicable. See worksheet in Appendix E. (Step 6)
- ❐ Identification of any conflicts with codes or requirements or other anticipated obstacles to implementing the Stormwater Control Plan (Step 8).
- ❐ General maintenance requirements for infiltration, treatment, and flow-control facilities (Step 9)
- ❐ Means by which facility maintenance will be financed and implemented in perpetuity. (Step 9)
- ❐ Statement accepting responsibility for interim operation & maintenance of facilities (Step 9).
- ❐ Construction Plan C.3 Checklist (Step 10).
- ❐ Certification by a civil engineer, architect, and landscape architect (Step 10).
- ❐ Appendix: Compliance with flow-control requirements (if using an HMP compliance option other than Option 2, Integrated Management Practices).

Step by Step

The Contra Costa Clean Water Program recommends that you plan and design your stormwater controls integrally with the site planning and landscaping for your project. It's best to start with general project requirements and preliminary site design concepts; then prepare the detailed site design, landscape design, and Stormwater Control Plan simultaneously.



If a site design has already been prepared, you may still be able to incorporate adequate stormwater controls. However, because you'll be working within the constraints of the design, you may be limited to selecting more expensive, higher-maintenance, and less aesthetically pleasing treatment and flow-control options.

The following step-by-step procedure should optimize your design by identifying the best opportunities for stormwater controls early in the design process.

The recommended steps are:

1. Assemble needed information.
2. Identify site opportunities and constraints.
3. Design to minimize imperviousness.
4. Select treatment and flow-control facilities and determine where they will be located.
5. Perform preliminary design of treatment and flow-control facilities.
6. Specify source controls.
7. Integrate the Stormwater Control Plan with site and landscape plans.
8. Identify permitting and code compliance issues.
9. Identify facility maintenance requirements.
10. Complete the Stormwater Control Plan.

Municipal staff may recommend you prepare and submit a preliminary site design prior to formally applying for planning and zoning approvals. Your preliminary site design should incorporate a conceptual plan for site drainage, including self-treating and self-retaining areas and the location and approximate sizes of any treatment and flow-control facilities. This additional up-front design effort will save time and avoid potential delays later in the review process.

Step 1: Assemble Needed Information

To select types and locations of treatment and flow-control facilities, the designer needs to know the following site characteristics:

- Existing natural hydrologic features and natural resources, including any contiguous natural areas, wetlands, watercourses, seeps, or springs.

- Existing site topography, including contours of any slopes of 4% or steeper, general direction of surface drainage, local high or low points or depressions, any outcrops or other significant geologic features.

- Zoning, including requirements for setbacks and open space.

- Soil types (including hydrologic soil groups) and depth to groundwater, which may determine whether infiltration is a feasible option for managing site runoff. Depending on site location and characteristics, and on the selection of treatment and flow-control facilities, site-specific information (e.g. from boring logs or geotechnical studies) may be required.

- Existing site drainage. For undeveloped sites, this should be obtained by inspecting the site and examining topographic maps and survey data. For previously developed sites, site drainage and connection to the municipal storm drain system can be located from site inspection, municipal storm drain maps, and plans for previous development.

- Existing vegetative cover and impervious areas, if any.

References and Resources

- Appendix C, Stormwater Infiltration Guidelines
- *Start at the Source* (BASMAA 1999), p. 36
- USDA NRCS Technical Release TR55 Documentation—Appendix A: Soil Types

Step 2: Identify Constraints & Opportunities

Review the information collected in Step 1. Identify the principal constraints on site design and selection of treatment and flow-control facilities as well as opportunities to reduce imperviousness and incorporate facilities into the site and landscape design. For example, **constraints** might include impermeable soils, high groundwater, groundwater pollution or contaminated soils, steep slopes, geotechnical instability, high-intensity land use, heavy pedestrian or vehicular traffic, or safety concerns. **Opportunities** might include existing natural areas, low areas, oddly configured or otherwise unbuildable parcels, easements and landscape amenities including open space and buffers (which can double as locations for BMPs), and differences in elevation (which can provide hydraulic head).

Prepare a brief **narrative** describing site opportunities and constraints. In the review process, this narrative may help establish the **maximum extent practicable** degree of stormwater control required for your site.

Step 3: Design to Minimize Imperviousness

► OPTIMIZE THE SITE LAYOUT

To minimize stormwater-related impacts, apply the following design principles to the layout of newly developed and redeveloped sites:

- Define development envelope and protected areas, identifying areas that are most suitable for development and areas that should be left undisturbed.
- Set back development from creeks, wetlands, and riparian habitats.
- Preserve significant trees.

Where possible, conform the site layout along natural landforms, avoid excessive grading and disturbance of vegetation and soils, and replicate the site's natural drainage patterns. Concentrate development on portions of the site with less permeable soils, and preserve areas that can promote infiltration.

Coordination
Chapter One includes a presentation of how review of your project's site design and landscape design is coordinated with review for compliance with Provision C.3.

► LIMIT PAVING AND ROOFS

For all types of development, **limit overall coverage** of paving and roofs. This can be accomplished by designing compact, taller structures, narrower and shorter streets and sidewalks, smaller parking lots (fewer stalls, smaller stalls, and more efficient lanes), and indoor or underground parking. Examine site layout and circulation patterns and identify areas where landscaping or planter boxes can be substituted for pavement.

► MINIMIZE DIRECTLY CONNECTED IMPERVIOUS AREA

With the built and landscaped areas defined on a site drawing, look for opportunities to minimize directly connected impervious area:

- Direct runoff from impervious areas to adjacent pervious areas or depressed landscaped areas. A 2:1 ratio of impervious to pervious area is generally acceptable where soils permit (except in hillside areas). As discussed in Chapter 5, much higher ratios (up to 25:1) can be used with an appropriately designed landscape infiltration/bioretention IMP, which may require a subsurface liner and/or a perforated pipe underdrain.

- Select permeable pavements and surface treatments. Inventory paved areas on the preliminary site plan and identify locations where permeable pavements, such as crushed aggregate, turf block, or unit pavers can be substituted for impervious concrete or asphalt paving.

► DETAIN AND RETAIN RUNOFF THROUGHOUT THE SITE

- Use drainage as a design element. Use drainage swales, depressed landscape areas, vegetated buffers, and bioretention areas as amenities and focal points within the site and landscape design. In some cases, swales can be placed alongside roadways to convey and treat stormwater runoff.

- Minimize peak flow and volume of runoff. Design landscaped areas and incorporate Integrated Management Practices (IMPs, Steps 4 and 5) to detain or retain runoff to the maximum extent practicable.

► DOCUMENT YOUR DESIGN DECISIONS

Chapter Five describes how to document pervious and impervious areas within your project and how to quantify the benefits achieved by your design decisions to reduce paved and roofed areas, to create self-retaining landscaped areas and pervious pavements, and to direct runoff from impervious to pervious areas.

To accompany the table, prepare a brief narrative that documents the site layout and site design decisions you made that minimize imperviousness, retain or detain stormwater, slow runoff rates, and reduce pollutants in post-development runoff to the maximum extent practicable.

References and Resources

- *Start at the Source* (BASMAA, 1999).
- Your municipality's *General Plan*
- Your municipality's Zoning Ordinance and Development Codes
- *Low Impact Development Manual* (Maryland, 1999).
- *Site Planning for Urban Stream Protection* (Schueler, 1995b).

Step 4: Select Treatment/Flow-Control Facilities

In Step 3, you minimized the total quantity of runoff by reducing impervious area and directing runoff to pervious areas if and where possible. You also sketched the site's drainage system, divided the site into drainage areas, and tabulated pervious areas.

In this step, inventory and tabulate impervious areas and identify appropriate locations for facilities that will infiltrate, or detain and treat, runoff before it flows offsite. Then select the appropriate facilities. The opportunities and constraints identified earlier (in Step 2) will help guide this process.

Site constraints and the designer's professional judgment and preferences will ultimately guide your selection of treatment facilities. The suite of facilities must meet the criteria set in the RWQCB permit.

A first consideration in identifying a drainage and treatment strategy is to decide whether infiltration to groundwater is a practical option for the site. In general, the cheapest and most effective treatment BMPs are adequately sized areas, designed into site landscaping, that will infiltrate design flows to groundwater. In sites with space constraints, direct infiltration can be promoted by using surface infiltration basins, subsurface trenches or dry wells. However, in most Contra Costa locations, direct infiltration facilities are infeasible because of low-permeability soils, steep slopes, geotechnical instability, high groundwater, or a combination of these factors.

Direct infiltration to groundwater may not be used where:

- The infiltration facility would receive drainage from areas where chemicals are used or stored, where vehicles or equipment are washed, or where refuse or wastes are handled.
- Surface soils or groundwater are polluted.
- The facility could receive sediment-laden runoff from disturbed areas or unstable slopes.
- Soils are insufficiently permeable to allow the facility to drain within 72 hours.

The NPDES permit restricts the design and location of direct infiltration devices that, as designed, may bypass filtration through surface soils before reaching groundwater, including:

- Infiltration basins.
- Infiltration trenches (includes french drains).
- Unlined retention basins (i.e., basins with no outlets).
- Unlined or open-bottomed vaults or boxes installed below grade (includes bubble ups and permeable pavement with underground storage).s

These restrictions are detailed in Appendix C.

Facilities may use detention and treatment, rather than infiltration to groundwater, to manage runoff quality and flow.

Treatment is accomplished by either detaining runoff long enough for pollutants to settle out or by filtering runoff through sand or soil. Typically, the limiting design factors will be available space and available head (difference in water surface elevation between inflow and outflow). In some cases, a small adjustment of elevations within the site plan can make a treatment option feasible and cost-effective.

ICON KEY
Helpful Tip
Submittal Requirement
Terms to Look Up
References & Resources

A second consideration in developing a drainage and treatment strategy is whether to route most or all drainage through a single detention and treatment facility (conventional design) or to disperse smaller facilities (Low Impact Development Integrated Management Practices, or IMPs) throughout the site. Piping runoff to a single treatment area makes it easier to design site drainage in the conventional manner. However, Low Impact Development designs that integrate IMPs such as swales, small landscaped areas, and planter boxes throughout the site are typically more cost-effective, easier to maintain, and more aesthetically pleasing.

The Contra Costa Clean Water Program recommends the Low Impact Development approach.

► GUIDANCE FOR SELECTING TREATMENT AND FLOW-CONTROL FACILITIES

Swales, planter boxes, and bioretention areas have proven to be widely applicable IMPs for all types of development projects in Contra Costa. These facilities may be used to achieve compliance with both treatment and flow-control requirements.

Illustrations, drawings, and design criteria are for these and other IMPs are provided in fact sheets in Appendix C. Guidance for incorporating the IMPs into your site is in Chapter 5. Table 5-2 on page 71 provides, at a glance, ideas for selecting IMPs for specific site conditions.

► OTHER RESOURCES FOR SELECTING FACILITIES

Low Impact Development Strategies: An Integrated Design Approach (Prince George's County, Maryland, Department of Environmental Resources, 1999) guides the designer through the LID approach to stormwater control. The Low Impact Development Center has updates and the latest resources for applying LID. The *Low Impact Development Technical Guidance Manual for Puget Sound* (Puget Sound Action Team, 2005) includes many example technical specifications and implementation examples.

Implementation of IMPs is further detailed in Prince George's County's *Bioretention Manual* (updated 2001).

Urban Runoff Quality Management (Water Environment Federation Manual of Practice No. 23; American Society of Civil Engineers Manual and Report on Engineering Practice No. 87) focuses on larger, conventional facilities. For areas with less permeable soils (Hydrologic Soil Groups C & D), and where nutrients are not a major concern, the WEF/ASCE manual recommends extended detention, ponds with permanent pools, constructed wetlands, or media filtration.

The *California Stormwater BMP Handbook for New Development* includes useful technical advice and design criteria for conventional facilities.

Links to these and other manuals and design resources can be found on the Contra Costa Clean Water Program's new development web page. These manuals and guides should be used as a starting point for selection and design of treatment facilities that meet the RWQCB requirements and local codes. Keep in mind that the criteria and recommendations in these manuals may be different, or inapplicable, to projects in Contra Costa.

The overall design for the site must meet RWQCB requirements, local planning and zoning requirements, and applicable building codes.

The designs must also be maintainable. Maintenance requirements for treatment and flow-control facilities must be identified in the Stormwater Control Plan. (See Step 10 and Chapter 6.) A detailed Stormwater Facility Maintenance Plan will be required at the time of application for a Certificate of Occupancy.

► LOCATING TREATMENT FACILITIES ON YOUR SITE

Finding the right location for treatment and flow-control facilities on your site involves a careful and creative integration of several factors:

- To make the most efficient use of the site and to maximize aesthetic value, integrate swales, planter boxes, and bioretention areas (IMPs) with site landscaping. Many local zoning codes may require landscape setbacks or buffers, or may specify that a minimum portion of the site be landscaped. It may be possible to locate some or all of your site's treatment and flow-control facilities within this same area.

- Planter boxes, swales, bioretention areas and other IMPs require level or nearly level area. The area required is proportional to the impervious area draining to the IMP; the appropriate ratio (sizing factor) can be determined by following the instructions in Chapter 5 and using the sizing tool in Appendix I.

- For effective, low-maintenance operation, locate facilities so drainage into and out of the device is by gravity flow. Pumped systems can be feasible, but are expensive, require more maintenance, are prone to untimely failure, and can cause mosquito control problems. Most stormwater facilities require 3 feet or more of head.

- Consider final ownership and maintenance responsibility. If the facility will serve only one site owner, make sure it is located for ready access by inspectors from the local municipality and the Contra Costa Mosquito and Vector Control District. If the property is being subdivided now or in the future, the facility should be in a common, accessible area. Dedication of title or easement providing ownership and/or access to your local agency may be required at the time of subdivision. In particular, avoid locating facilities on private residential lots.

- The facility must be accessible to equipment needed for its maintenance. Access requirements for maintenance will vary with the type of facility selected. For example, planter boxes or biofiltration swales will typically need access for the same types of equipment used for landscape maintenance. Wet or dry detention ponds typically require maintenance roads that can be used by heavy vehicles for dredging and control of emergent vegetation. Vaults and underground filters may require special equipment for periodic clean out and media replacement. See Chapter Six for typical maintenance requirements for various types of facilities.

References and Resources

- Appendix C
- RWQCB R2-2003-0022, Provision C.3.d
- *Urban Runoff Quality Management* (WEF/ASCE, 1998).
- *Low Impact Development Design Strategies: An Integrated Approach* (Maryland, 1999)
- *Site Planning for Urban Stream Protection* (Scheuler, 1995)
- *Stormwater Manual* (City of Portland, 2004).
- *California Stormwater BMP Handbooks*
- *Minnesota Urban Small Sites BMP Manual* (Barr Engineering, 2001)
- *Low Impact Development Technical Guidance Manual for Puget Sound* (Puget Sound Action Team, 2005)
- *LID for Big Box Retailers* (Low Impact Development Center, 2006)

Step 5: Perform Preliminary Design of Facilities

Demonstrate the feasibility and effectiveness of the treatment and flow-control facilities you selected by showing that they meet the design criteria in Chapter Five. Detailed construction drawings are not required at this stage, but drawings or sketches will be needed to illustrate the proposed design and to support calculations.

► COMPLIANCE WITH FLOW-CONTROL REQUIREMENTS

Projects that create or replace an acre or more of impervious area must demonstrate compliance with flow-control requirements as well as treatment requirements. See Table 1-1 on page 5.

If your project is subject to flow-control requirements, decide whether you want to use Low Impact Development IMPs to comply with flow-control requirements as well as treatment requirements. If so, you will select this option when using the CCCWP's IMP sizing tool.

Your other options for demonstrating flow-control compliance are summarized in Table 1-3 on page 12 and in Appendix D. If you choose one of these other options, you can still use the Program's IMP sizing tool to design IMPs for treatment only.

► DESIGN PROCEDURE

Chapter Five provides instructions for design and documentation using Low Impact Development. The procedure includes detailed accounting of pervious and impervious areas and demonstration that each facility is adequately sized to manage runoff from its tributary impervious area. See page 60. The Contra Costa Clean Water Program recommends that you use this procedure when preparing your Stormwater Control Plan.

► SUBMITTAL REQUIREMENTS

As described in the checklist on page 24, your Stormwater Control Plan Exhibit must show:

- The entire site divided into separate drainage areas, with each area identified as self-retaining, self-treating, or draining to a treatment/flow control facility. Each area should be clearly marked with a unique identifier.

- For each drainage area, the types of impervious area proposed, and the area of each.

- Proposed locations and sizes of infiltration, treatment, or flow-control facilities. Each facility should be clearly marked with a unique identifier.

Your Stormwater Control Plan must also include:

- A tabulation of proposed self-treating areas, self-retaining areas, areas tributary to infiltration, treatment, or flow-control facilities, and the corresponding facilities identified on the Exhibit. The CCCWP's IMP Sizing Tool is designed to prepare this tabulation for you.

- Preliminary designs for each infiltration, treatment, or flow-control facility. The fact sheets and accompanying drawings in Appendix C may be used or adapted for this purpose. The CCCWP's IMP Sizing tool is designed to complete and document the appropriate sizing calculations.

Step 6. Specify Source Control BMPs

Some everyday activities – such as trash recycling/disposal and washing vehicles and equipment – generate pollutants that tend to find their way into storm drains. These pollutants can be minimized by applying **source control BMPs**.

Source control BMPs include **permanent**, structural features that must be incorporated into your project plans and **operational** BMPs, such as regular sweeping and "housekeeping," that must be implemented by the site's occupant or user. The maximum extent practicable standard typically requires both types of BMPs. In general, operational BMPs cannot be substituted for a feasible and effective permanent BMP.

Use the following procedure to specify source control BMPs for your site:

► IDENTIFY POLLUTANT SOURCES

Review your preliminary site plan. Then review the first column in the Pollutant Sources/Source Control Checklist (Appendix E). Check off the potential sources of pollutants that apply to your site.

► NOTE LOCATIONS ON SITE PLAN

Note the corresponding requirements listed in Column 2 of the Pollutant Sources/Source Control Checklist (Appendix E). Incorporate these items into your Stormwater Control Plan drawings.

► PREPARE A TABLE AND NARRATIVE

Check off the corresponding requirements listed in Column 3 in the Pollutant Sources/Source Control Checklist (Appendix E). Now, create a table using the format in Table 3-1. In the left column, list each potential source on your site (from Appendix E, Column 1). In the middle column, list the corresponding permanent, structural BMPs (from Columns 2 and 3, Appendix E) used to prevent pollutants from entering runoff. Accompany this table with a narrative that explains any special features, materials, or methods of construction that will be used to implement these permanent, structural BMPs.

TABLE 3-1. Format for table of permanent and operational source control measures.

Potential source of runoff pollutants	*Permanent source control BMPs*	*Operational source control BMPs*

► IDENTIFY OPERATIONAL SOURCE CONTROL BMPS

To complete your table, refer once again to the Pollutant Sources/Source Control Checklist (Appendix E, Column 4). List in the right column of your table the operational BMPs that should be implemented as long as the anticipated activities continue at the site. The local stormwater ordinance requires that these BMPs be implemented; the same BMPs may also be required as a condition of a use permit or other revocable discretionary approval for use of the site.

References and Resources

- Appendix E, Stormwater Pollutant Sources/Source Control Checklist
- RWQCB Order R2-2003-0022, Provision C.3.k
- *Start at the Source*, Section 6.7: Details, Outdoor Work Areas
- *California Stormwater Industrial/Commercial Best Management Practice Handbook*
- *Urban Runoff Quality Management* (WEF/ASCE, 1998) Chapter 4: Source Controls

Step 7: Integrate With Other Preliminary Drawings

Depending on the complexity of the project, the Stormwater Control Plan drawing may be combined with the site plan, landscape plan, or drainage plan. In any case, the Stormwater Control Plan should be carefully coordinated with these plans, with site grading and drainage, and with construction-phase erosion and sediment control plans.

Here are some typical considerations that may arise in coordinating stormwater control plans with other construction plans:

Excess fill. Excavation for landscape detention areas, swales, and other BMPs—and overexcavation/ replacement of clay soils with more permeable soils— can alter the cut-and-fill balance for site grading and preparation. By considering this issue early in site design, it may be possible to avoid excessive export of soil from the site.

Local Requirements
Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Compaction of soils during construction. Compaction from construction traffic can radically reduce the infiltration capacity of site soils. Construction staging plans should set aside and protect areas that will be used for self-retaining areas, infiltration, or IMPs.

Building Drainage. Building codes require that drainage from roofs and impervious areas be drained away from the building. The codes also specify minimum sizes and slopes for roof leaders and drain piping. Detailed designs of BMPs located in or on the building, or that may affect building foundations, must accommodate these codes while also meeting the minimum requirements for detention or flow stated in Provision C.3.

Control of elevations. Distribution of overland flow to landscaped areas may require that grading and landscape plans be executed with greater attention to slopes and elevations. Here are two typical problems to avoid:

- Inadequate reveal between pavement and vegetated areas. Provide adequate reveal (drop) at the edge of pavement to accommodate the growth of turf or other vegetation in an adjacent filter strip, swale, or landscape retention area. Otherwise, runoff will tend to pond on the edge of the paved surface.

- Differential settlement. The soil in filter strips, swales, and landscape retention areas must be left loose and uncompacted. However, concrete structures (e.g. inlets and outlets) must be supported on a firm foundation. Otherwise, they will tend to settle more than the surrounding ground, creating depressions which may harbor mosquito larvae.

Drainage Plans. The local building or engineering department may require a drainage plan when the project final design is submitted for plan check. In most cases, the drainage plan is designed to prevent street flooding during a 10-year storm and successfully route flows from a 100-year storm. To meet the requirements for both the Stormwater Control Plan design storm and the Drainage Plan design storm, BMP designs must incorporate bypasses or overflows to route excess flows to the storm drain system. It may be necessary to complete a preliminary drainage plan at the planning and zoning review stage.

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Submittal Requirement
Terms to Look Up
🕮 References & Resources

Plant selection. Depressed landscaped areas, bioretention areas, vegetated swales, and many other BMPs require appropriate plant selection to work properly. Plant selection should be coordinated with or incorporated into the landscape plan.

Note the "dry" swales, planter boxes, and bioretention areas (IMPs in Appendix C) require a sandy loam soil and are equipped with underdrains. Periods of inundation will be brief, and the plants selected should be suitable to a well-drained, sandy soil. Appendix L contains a list of plants which may be suitable to these IMPs. (As with other information in this *Guidebook*, check the CCCWP's C.3 web page at http://www.cccleanwater.org/construction/nd.php for updates.)

Local codes require landscaping to be designed for water conservation and may also encourage the use of native or other drought-tolerant plants. Some also require potable water not be used for irrigation where recycled water is available.

Access for periodic maintenance. All BMPs will require access for periodic inspection in accordance with an approved maintenance plan. Many BMPs (e.g., bioretention basins and swales) require relatively little maintenance, but others (e.g., sand filters or proprietary devices) may require regular replacement of surface sand or replacement of cartridges or inserts. Site plans should provide for the necessary access for personnel and equipment. If BMPs are to be maintained by a public agency, then a deeded access easement may be required. See Step 9.

Organizing traffic and parking. Your Stormwater Control Plan may call for depressing landscaped areas below paved areas rather than setting them above paved areas and surrounding them with curbs. Striping or bollards may be needed to guide traffic. Parking lots with crushed aggregate, unit-paver, and other permeable pavements may also require bollards or signs to organize parking.

References and Resources

- Appendix L, Plant List
- Your Municipality's Municipal Code (See Appendix A)
- Your Municipality's Standard Engineering Drawings
- *Bioretention Manual,* Prince George's County, 2002

Step 8: Permitting & Code Compliance Issues

To meet the RWQCB's "maximum extent practicable" standard, Stormwater Control Plans will typically need to incorporate innovative site design features, pavements, drainage design practices, and infiltration or detention-and-treatment facilities. Because these practices are new, there may be inconsistencies with existing building codes, engineering requirements, and standard conditions of approval.

The Contra Costa Clean Water Program makes no representation that the design practices or recommendations in this Guidebook (or in the publications listed as references and in the bibliography) meet existing applicable codes or standards.

Where conflicts occur between recommended stormwater control practices and existing codes and standards, municipal staff will work with the applicant to identify one or more regulatory or design solutions that can satisfy all applicable requirements.

Discuss with municipal planning staff any potential conflicts you note in the Stormwater Control Plan. By doing so, it may be possible to resolve the issue prior to final design. This will help avoid the need for redesign and resubmittal of final plans and associated project delays.

Step 9: Plan for Facility Maintenance

As required by NPDES Permit Provision C.3.e, your local municipality will periodically verify that treatment and flow-control facilities on your site are maintained and continue to operate as designed.

To make this possible, your municipality will require that you:

1. Specify, in your Stormwater Control Plan, a means to finance and implement facility maintenance in perpetuity.

2. Include in your Stormwater Control Plan the project developer's signed statement accepting responsibility for maintenance from the

time the facilities are constructed until responsibility for operation and maintenance is legally transferred.

3. Specify, in your Stormwater Control Plan, general maintenance requirements for the treatment and flow-control facilities you have selected.

4. Prepare and submit, before applying for building permit final and Certificate of Occupancy, a detailed Stormwater Control Operation and Maintenance Plan that sets forth a maintenance schedule for each of the treatment and flow-control facilities built on your site.

A summary of these requirements follows. See Chapter Six for additional detail.

► SPECIFY A MEANS TO FINANCE AND IMPLEMENT BMP MAINTENANCE

Your Stormwater Control Plan must specify a means to **finance and implement maintenance** of treatment and flow-control facilities **in perpetuity**.

Depending on the intended use of your site and the policies of your municipality, this may require one of the following:

- Dedication of fee title or easement transferring ownership of the facility (and the land under it) to the municipality.
- Execution of a maintenance agreement that "runs with the land."
- Application for a permit for the site owner to operate the facility.
- Formation of a new benefit assessment district or other special district, or addition of the properties to an existing special district (Proposition 218 election).
- Creation of a homeowners association (HOA) and execution of an agreement by the HOA to maintain the facilities as well as an annual inspection fee.

Experience has shown provisions to finance and implement maintenance of treatment and flow-control facilities can be a major stumbling block to project approval, particularly for **small residential subdivisions**. Applicants are encouraged to begin discussions with municipal staff at the initial pre-application meeting and execute initial agreements prior to obtaining planning and zoning approvals.

Your municipal planner or other representative will help you determine which of these apply to your project and will specify what must be included in your Stormwater Control Plan.

► DEVELOPER'S SIGNED STATEMENT

Include in your Stormwater Control Plan a statement to the effect:

> The applicant accepts responsibility for interim operation and maintenance of stormwater treatment and flow-control facilities until such time as this responsibility is formally transferred to a subsequent owner.

► MAINTENANCE NEEDS AND YOUR STORMWATER CONTROL PLAN

Include in your Stormwater Control Plan a general description of anticipated facility maintenance requirements. This will help ensure that:

- Ongoing costs of maintenance have been considered in your facility selection and design.
- Site and landscaping plans provide for access for inspections and by maintenance equipment.
- Landscaping plans incorporate irrigation requirements for facility plantings.
- Initial maintenance and replacement of facility plantings is incorporated into landscaping contracts and guarantees.

Chapter Six includes a discussion of **typical maintenance requirements** for some commonly used treatment and flow-control facilities.

In your Stormwater Control Plan, you should also note issues or concerns, specific to your site or to a specific BMP installation, to be followed up during the detailed design and construction phases of your project. For example, it may be necessary to verify that weirs and flow spreaders remain level and that sediment and debris accumulated during construction does not fill depressions or clog inlets and outlets. These items to be verified post-construction should be included in the Stormwater Control Plan.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

► STORMWATER CONTROL OPERATION AND MAINTENANCE PLAN

Your local municipality will require submittal of a draft **Stormwater Control Operation and Maintenance Plan** (O&M Plan) with your building permit application. A final O&M Plan must be submitted prior to issuance of a certificate of occupancy. Instructions for preparing an O&M Plan are in Appendix F. Your

O&M plan will list all treatment and flow-control facilities on the site along with the required periodic maintenance.

Except for facilities that are transferred to the public, the municipality will typically require an annual report to verify that maintenance has been done. The municipality will also require that the O&M Plan be kept on site. Municipal inspectors will refer to the O&M Plan during site visits.

References and Resources

- *Appendix F, Preparing Your Stormwater Control Operation and Maintenance Plan*
- *Model Stormwater Ordinance (CCCWP, 2005)*
- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- *Stormwater Management Manual* (Portland, 2004). Chapter 3.
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003).
- *Best Management Practices Guide* (Public Telecommunications Center for Hampton Roads, 2002).
- Contra Costa Clean Water Program *Vector Control Plan*
- Operation, Maintenance, and Management of Stormwater Management Systems (Watershed Management Institute, 1997)

Step 10: Stormwater Control Plan & Report

Your Stormwater Control Plan Report should document the information gathered and decisions made in Steps 1-10. A clear, complete, well-organized report will make it possible to confirm that the "maximum extent practicable" standard has been applied in each aspect of the project design.

► SAMPLE OUTLINE AND CONTENTS

I. Project Setting

   A. Project Name, Location, Description

   B. Existing site features and conditions

   C. Opportunities and constraints for stormwater control

II. Measures to Limit Imperviousness

   A. Measures to cluster development and protect natural resources

   B. Measures used to limit directly connected impervious area

      (1) Site design features

      (2) Pervious pavements

      (3) Detention and drainage design

C. Table summarizing pervious and self-retaining areas.

III. Selection and Preliminary Design of Treatment and Flow-Control Facilities

A. Locations and elevations

B. Sizing calculations

C. Table summarizing impervious areas and treatment/flow-control facilities

IV. Source Control Measures

A. Description of site activities and potential sources of pollutants

B. Table showing sources and permanent source controls

C. List of operational source control BMPs

V. Summary of Permitting and Code Compliance Issues

VI. Facility Maintenance Requirements

A. Ownership and responsibility for maintenance in perpetuity.

(1) Commitment to execute any necessary agreements.

(2) Statement accepting responsibility for operation and maintenance of facilities until that responsibility is formally transferred.

B. Summary of maintenance requirements for each BMP.

VII. Construction Plan C.3 Checklist

VIII. Certification

Appendix: Compliance with Flow-Control (Hydrograph Modification Management) requirements (if IMPs are not used).

► CONSTRUCTION PLAN C.3 CHECKLIST

When you submit construction plans for City review and approval, the plan checker will compare that submittal with your Stormwater Control Plan. By creating a Construction Plan C.3 Checklist for your project, you will facilitate the plan checker's comparison and speed review of your project.

TABLE 3-2. Format for Construction Plan C.3 Checklist.

Stormwater Control Plan Page #	*BMP Description*	*See Plan Sheet #s*

Here's how:

1. Create a table similar to Table 3-2. Number and list each measure or BMP you have specified in your Stormwater Control Plan in Columns 1 and 2 of the table. Leave Column 3 blank. Incorporate the table into your Stormwater Control Plan.

2. When you submit construction plans, duplicate the table (by photocopy or electronically). Now fill in Column 3, identifying the plan sheets where the BMPs are shown. List all plan sheets on which the BMP appears. Submit the updated table with your construction plans.

Note that the updated table—or Construction Plan C.3 Checklist—is only a reference tool to facilitate comparison of the construction plans to your Stormwater Control Plan. Planning Department staff can advise you regarding the process required to propose changes to the approved Stormwater Control Plan.

► CERTIFICATION

Your local municipality may require that your Stormwater Control Plan be certified by an architect, landscape architect, or civil engineer. See Appendix A. Certification should state: "The selection, sizing, and preliminary design of treatment BMPs and other control measures in this plan meet the requirements of Regional Water Quality Control Board Order R2-2003-0022 and subsequent amendments."

► EXAMPLE STORMWATER CONTROL PLANS

Example Stormwater Control Plans are in Appendix G (on the CCCWP's C.3 web page). Your Stormwater Control Plan will reflect the unique character of your own project and should meet the requirements identified in this *Guidebook*. Municipal staff can assist you to determine how specific requirements apply to your project.

Chapter

4

Stormwater Control & CEQA

Incorporating stormwater impacts and control measures into Initial Studies and Environmental Impact Reports

CEQA—the California Environmental Quality Act—requires local jurisdictions to identify and evaluate the environmental impacts of their actions, including zoning decisions and discretionary land-use approvals. The CEQA process makes decision makers and the public aware of potential adverse environmental impacts and prevents environmental damage by requiring implementation of feasible alternatives or mitigation measures.

Further guidance on the CEQA process is available from your local Planning or Community Development department and from the references and resources listed on page 50. This chapter clarifies how information in your Stormwater Control Plan may be used in the CEQA process.

The CEQA process is typically conducted in three phases:

1. Preliminary review to determine if the project is subject to CEQA.
2. Preparation of an Initial Study to determine the environmental effects of the project.*
3. Preparation of an Environmental Impact Report (EIR), Negative Declaration, or Mitigated Negative Declaration.

Your Stormwater Control Plan contains information to be reviewed during one or more of these phases of the CEQA process.

* The lead agency may choose to skip the Initial Study and proceed directly to an EIR.

Preliminary Review

CEQA review begins with a pre-application consultation at your local municipality's planning or community development department. At this meeting, a planner will help you identify specific issues that must be addressed in your application for planning and zoning approval.

If your project is subject to the C.3 Provisions—i.e., creates or replaces impervious area in excess of the applicable threshold—a complete Stormwater Control Plan should be part of this application.

By submitting a complete and adequate Stormwater Control Plan with your application for planning and zoning approval, you may be able to avoid further CEQA review for long-term (post-construction) stormwater impacts.

To determine if your project is also subject to CEQA, municipal planning staff will typically require that you complete an Environmental Information Form as part of your application for planning and zoning review. Depending on your project's scope, your municipality may require additional information and documentation.

Local Requirements

Check Appendix A now to see if your local municipality has specified procedures for CEQA review, and talk to a local planner before commencing work on CEQA or C.3 documentation.

If your project is not subject to CEQA—e.g., because of a statutory or categorical exemption—your local agency may choose to file a Notice of Exemption. Filing a notice reduces the length of time that the agency's decision is subject to challenge. Any C.3 requirements for your project will still apply.

If your project is not exempt from CEQA, planning or community development staff will complete an Environmental Checklist and Initial Study. Depending on the results of the Initial Study, the planner may recommend a Negative Declaration or Mitigated Negative Declaration be issued for the project, or recommend that an Environmental Impact Report be prepared.

Initial Study

NPDES permit provision C.3.m requires local municipalities to evaluate water quality effects and identify appropriate mitigation measures when they conduct environmental review of proposed projects.

The Governor's Office of Planning and Research (OPR) recommends that CEQA lead agencies should integrate CEQA review "to the fullest extent possible" with review for compliance with Federal, state, or local laws, regulations, or policies (*CEQA Guidelines* §15124(d)(1)(C)). In 1998, OPR revised the example Environmental Checklist Form (CEQA Guidelines Appendix G) to more closely align with Federal and state laws and requirements, including those of the state's Fish and Game Code, the Federal Clean Water Act, and the California Water Code. Most municipalities use the OPR Environmental Checklist Form or a variation thereof.

Questions on the Environmental Checklist Form connect potentially significant project impacts with water-quality regulations. For example:

- Question VIII.a asks: "Would the project violate any water quality standards or waste discharge requirements?"

- The potential effects of increased runoff peak flows and durations are addressed in question VIII.c: "Would the project substantially alter the existing drainage pattern of the site or area, including through the alteration of the course of a stream or river, in a manner which would result in substantial erosion or siltation off-site?

- Potential impacts of runoff pollutants are targeted in Question VIII.e, which asks: "Would the project create or contribute runoff water which would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff?"

- Finally, Question VIII.f. asks: "Would the project otherwise substantially degrade water quality?"

The C.3 provisions include suitable criteria for determining that a project could not contribute "substantial additional sources" of runoff or pollutants.

► THRESHOLDS OF SIGNIFICANCE

A threshold of significance is "a quantitative or qualitative standard, or set of criteria, pursuant to which the significance of an environmental effect may be determined." (OPR 1994). Thresholds are not rigid or absolute—the significance of an activity depends on its specific location—but they do help Lead Agencies make consistent and well-supported determinations.

In most cases, your local municipality will regard projects that exceed the threshold in NPDES permit provision C.3.c., defined therein as a "Group 1 project," to have potentially significant impacts (unless mitigated) due to increases in runoff pollutants over the life of the project.*

* Construction-phase impacts should be addressed in a Storm Water Pollution Prevention Plan, which is required for projects that disturb an acre or more. See page 8.

This threshold is one acre of new impervious area for projects with applications deemed complete on February 15, 2005 or later, and 10,000 square feet of new impervious area for projects with applications deemed complete on August 15, 2006 or later. The threshold does not apply to projects for which the municipality has issued a waiver of the requirements for treatment facilities as provided in NPDES permit Provision C.3.g. The CEQA threshold and C.3 requirements are intended to address both cumulative and site-specific increases in runoff pollutants due to imperviousness.

A project may also have potentially significant impacts due to increases in runoff pollutants if the facility includes outdoor storage of materials or wastes or if it accommodates outdoor activities such as automotive or equipment repair. Examples include car washes, grocery stores, some restaurants, and corporation yards. The threshold of significance in this case is qualitative and requires project-specific assessment of the potential for pollutants generated on-site to reach storm drains.

Increased site imperviousness may, by increasing the peaks and durations of runoff, potentially increase erosion of the beds and banks of downstream watercourses. In most cases, the threshold of significance for this impact is no increase in runoff peaks and durations, although there may be exceptions. The Contra Costa Clean Water Program's Hydrograph Modification Management Plan (HMP) specifies methods for determining whether a project will increase runoff peaks and durations when compared against the existing condition of the site. In some cases, it may be possible to increase runoff peaks and durations without having a significant impact on erosion of downstream watercourses. Appendix D specifies methods for determining whether this is the case for a particular site.

► FORMS AND CHECKLISTS

If a project is required to implement stormwater BMPs, the potential for significant stormwater impacts should be noted on the Environmental Information Form. If OPR's form (*CEQA Guidelines* Appendix H) is used, this is Question 26 (Change in ocean, bay, lake, stream, or ground water quality or quantity or alteration of existing drainage patterns). Reference the Stormwater Control Plan for the project when completing the Environmental Information Form.

If the Stormwater Control Plan for the project meets the criteria in NPDES permit C.3.d and incorporates recommended source control measures for each potential source of pollutants identified, then the relevant questions regarding stormwater quality in the Initial Study Checklist can, in most cases, be answered "less than significant with mitigation incorporation." The initial study should note the specific source control and treatment facilities incorporated and reference the Stormwater Control Plan.

Negative Declaration or EIR

If the Initial Study finds that your project could have a significant environmental impact, a mitigated Negative Declaration or Environmental Impact Report must be prepared.

In general, the implementation of treatment facilities (BMPs) that meet the numeric criteria in Provision C.3.d, as described in Chapter 5, will mitigate the effects of increased imperviousness on water quality to a level that is less than significant. Similarly, implementation of recommended source control BMPs for each identified source of potential pollutants will effectively mitigate the creation of these additional sources.

Methods for demonstrating that flow-control facilities mitigate potential increases in runoff peaks and durations are in Appendix D.

The preparer of the EIR or other CEQA document may decide where and how to include detailed information from the Stormwater Control Plan—in the body of the CEQA document, as an appendix, or by reference.

Stormwater Impacts and the CEQA Process

In summary, municipalities may use the criteria in the C.3 provisions to specify thresholds of significance for stormwater impacts and also to identify and evaluate measures required to mitigate those impacts.

If the amount of impervious area created by a project is less than the threshold identified in NPDES permit provision C.3.c, and there are no significant new sources of runoff pollutants created by the project, then the relevant questions on the Initial Study Checklist can be answered “less than significant impact.”

If the amount of impervious area created by a project exceeds the C.3.c threshold, and the project’s Stormwater Control Plan incorporates the appropriate BMPs, a municipality may find that the project could not have a significant impact on stormwater quality.

Note that in some cases, a project may be below the impervious-area threshold in Provision C.3.c but could still create a significant new source of potential runoff pollutants. This might occur, for example, with an application for a use permit for a new business (say, a car wash) on an already fully developed (and impervious) site. In these cases, potential impacts can be mitigated through incorporation of appropriate permanent and operational source control BMPs.

Source control or treatment BMPs must be maintained for the life of the project to effectively mitigate the potential environmental effect. Similarly, operational

BMPs must be implemented thoroughly and consistently to be effective mitigations. Monitoring of permanent BMPs will be accomplished through the municipal BMP verification program (Chapter Six). The municipality also inspects industrial and commercial sites to verify consistent use of operational BMPs.

References and Resources

- California Environmental Quality Act Statutes
  (Public Resources Code §21000 *et seq.*)
- Governor's Office of Planning and Research—
  CEQA Guidelines (14 Cal. Code Regs.) and other resources.
- Environmental Information Form (*CEQA Guidelines* Appendix H)
- Environmental Impact Assessment Form
  (Initial Study Checklist—*CEQA Guidelines* Appendix G)
- CEQA Deskbook (Bass, et. al., 2001)

Chapter
5

Technical Requirements

Technical guidance for designing site drainage, stormwater treatment facilities, and flow-control facilities

Your Stormwater Control Plan is to be submitted with your application for planning and zoning approvals. Its purpose is to demonstrate how your project will comply with applicable stormwater treatment standards and flow-control (hydrograph modification management) standards.

This will require careful documentation of:

- Pervious and impervious areas on the development site.
- Drainage from each of these areas.
- Locations, sizes, and types of proposed treatment and flow-control facilities.

Your Stormwater Control Plan must also include calculations showing the site drainage and treatment and flow-control facilities meet the criteria in this Guidebook.

During plan check, local agency staff will verify site drainage and treatment and flow-control facilities are designed to implement your approved Stormwater Control Plan.

The Contra Costa Clean Water Program has created the following resources to help you design your project drainage, including treatment and flow-control facilities:

- A procedure, described in this chapter, for designing and documenting site drainage using the “Low Impact Development” (LID) approach (also called the “Start at the Source” approach).

- Designs and design criteria for seven LID Integrated Management Practices (IMPs) which may be used to meet standards for stormwater treatment and flow control (Appendix C).

- A design procedure and interactive computer-based tool which can be used together to document site drainage and calculate the required minimum sizes of LID IMPs. A printout can be included in your Stormwater Control Plan.

This chapter has three parts.

The first part explains applicable technical criteria for sizing treatment facilities, interprets the RWQCB's aims in establishing the criteria, and refers to the documents, studies, and rationales on which the criteria are based. This first part also documents the CCCWP's rationale for selecting specific criteria to be applied in Contra Costa from among the alternative sizing criteria allowed by the RWQCB.

The first part also summarizes the rationale for the flow-control standard and explains your options for demonstrating compliance.

ICON KEY
☞ Helpful Tip
Submittal Requirement
Terms to Look Up
🕮 References & Resources

The second part of this chapter provides guidance for design and documentation of site drainage, treatment facilities, and flow-control facilities.

The third part of Chapter Five includes design tips and references to available design manuals.

Part 1: Stormwater Control Technical Criteria

The NPDES C.3. provisions require a complex, multifaceted approach to on-site stormwater control. In effect, project applicants must implement several different, independent measures to control stormwater pollutants, and each of these measures must independently meet a maximum extent practicable standard.

Specifically, applicants must:

- Control pollutant sources to the maximum extent practicable.

- Implement site design and landscape features which reduce runoff pollutants to the maximum extent practicable.

- Control increases in peak flows and durations (implement flow control/hydrograph modification management) to the maximum extent practicable.

Most measures of "maximum extent practicable" are qualitative and are based on professional judgment and current practices. However, the NDPES permit includes **numeric criteria** for the design of treatment facilities and flow-control facilities.

Terminology

"Hydrograph Modification Management," "HMP requirements" and "flow control" all refer to the same standard and criteria. The Contra Costa Clean Water Program is using "flow the terms "flow control" and "flow control facility" because they are shorter, more accurate, and more descriptive.

Numeric criteria for treatment facilities are intended to ensure the facilities are adequately sized to remove a significant proportion of pollutants in runoff.

Numeric criteria for flow control facilities are in the NPDES permit's **flow-control (hydrograph modification management) standard:**

> …estimated post-project runoff peaks and durations do not exceed estimated pre-project peaks and durations if increased stormwater runoff peaks or durations could cause erosion or other significant effects on beneficial uses.

Criteria for stormwater treatment and criteria for flow control are separate and independently applicable.

Your design of site drainage, treatment facilities, and flow-control facilities must demonstrate that both sets of criteria are met.[*]

Requirements for control of peak flows and durations are depend on your site's soils and the extent of existing impervious areas. In contrast, the stormwater treatment criteria will be the same regardless of how, or whether, your site was previously developed.

► LIMITS ON THE USE OF DIRECT INFILTRATION

RWQCB permit Provision C.3.i. requires "treatment measures that function primarily as **infiltration devices**"—structures that are designed to infiltrate stormwater directly into the subsurface and, as designed, bypass the natural groundwater protection afforded by filtration through surface or near-surface soil—to have a 10-foot vertical separation from the "seasonal high groundwater mark." Direct infiltration facilities include but are not limited to **dry wells, infiltration trenches, and infiltration basins.** These facilities should not serve

[*] Treatment control requirements apply to projects with planning and zoning applications deemed complete on or after February 15, 2005 (August 15, 2006 for projects creating or replacing between 10,000 square feet and one acre of impervious area). HMP requirements apply to projects with planning and zoning applications deemed complete on or after October 14, 2006. See Chapter 1 and Table 1-1 regarding applicability of the flow-control standard.

work areas, including automotive shops, car washes, fleet storage, nurseries, or other areas that may be significant sources of pollutants. Swales, planter boxes, and bioretention areas treat stormwater prior to infiltration and may be used in these circumstances.

In many areas of Contra Costa, high groundwater or low-permeability soils preclude the use of infiltration. In some other areas, steep slopes and geological instability make infiltration inadvisable. See Appendix C for guidance that will help you determine whether infiltration can be used for stormwater treatment or disposal on your site.

If direct infiltration is feasible, the design criteria and procedures in Appendix C will help you design infiltration devices appropriate to your project. If infiltration devices are not appropriate, you can still use swales, planter boxes, and bioretention areas equipped with underdrains.

► NUMERIC CRITERIA FOR STORMWATER TREATMENT FACILITIES

The NPDES permit specifies hydraulic design criteria for treatment facilities. Depending on the type of facility, the criteria used can be based either on volume or flow. Detention basins, which depend on settling to remove pollutants, and dry wells, which detain runoff for infiltration into native soils, are examples of facilities with a volume hydraulic design basis. Filters and swales are designed to a flow hydraulic design basis.

Both volume-based and flow-based treatment criteria aim to ensure approximately 80% of the total volume of future runoff is treated prior to discharge to municipal storm drains. See the discussion of design storm in Chapter 2.

Note these criteria for sizing treatment facilities are different from the flow-control criteria, which are separate and independently applicable.

► VOLUME HYDRAULIC DESIGN BASIS FOR TREATMENT FACILITIES

The RWQCB permit specifies two alternative methods for calculating water quality volume, the volume of water that must be detained for a BMP to meet the "maximum extent practicable" criterion for stormwater treatment. The first method is stated in the book *Urban Runoff Quality Management* (Water Environment Federation Manual of Practice No. 23; ASCE Manual and Report on Engineering Practice No. 87, 1998) and is referred to as the WEF Method. The second method is in Appendix D of the *California Storm Water Best Management Practice Handbook (Municipal)* (SWQTF, 1993) and is referred to as the California BMP Method.[*]

[*] The 2003 edition of the *California Storm Water Best Management Practices Handbook* (CASQA, 2003, available at www.cabmphandbooks.org) also describes this method, with some minor revisions.

The two methods are based on the same hydrological methodology, and they tend to yield similar results. Both are suited for the design of conventional treatment facilities that use engineered outlet structures to control the time it takes for the facility to drain. The methods differ in some aspects of their practical application.

Both methods use long-term rainfall records to identify the depth of rainfall during a design storm for stormwater treatment. Approximately eighty percent of total annual runoff is produced by storms that produce rainfall depths equal to or less than the design storm depth. The design storm depth for stormwater treatment varies from (roughly) 0.45 to 0.85 inches in Contra Costa County.

The WEF method requires that the designer specify a drawdown time of 12, 24, or 48 hours. Longer drawdown times require larger BMP volumes (because of the potential for back-to-back storms). Although the permit does not specify a drawdown time, the longer time (48 hours) has been recommended because sediments from the Bay Area's fine-grained soils require a relatively long time to settle out. The California BMP method uses a fixed drawdown time of 40 hours.[*]

The WEF method is based on 80% capture of average annual runoff. The California BMP Method allows the designer to select a capture ratio; however, the RWQCB permit specifies that an 80% capture ratio be used.

The WEF method requires estimation of a mean storm precipitation volume. This can be based on local rainfall data. The analysis is conducted by taking periodic (e.g. hourly) rain gauge data, identifying distinct storms, calculating the total rainfall depth of each, and taking an average. The California BMP method incorporates this analysis into a nomograph for the specific locality.

The WEF method requires calculation of a composite (weighted) runoff coefficient for the area that is tributary to the facility being designed. The method provides a formula for calculating the runoff coefficient from the "watershed imperviousness ratio," or the percent total imperviousness.

Similarly, the California BMP Method requires estimation of Directly Connected Impervious Area (DCIA). As stated in SWQTF (1993), "the percentage of impervious area directly connected to the storm drain system. DCIA is defined as the area covered by pavement, building, and other impervious surfaces which drain directly into a storm drain without first flowing across pervious areas (e.g. lawns)." Conceptually, the tributary drainage is divided into areas that are either wholly pervious or wholly impervious.

[*] The 2003 revision to the California BMP Handbooks uses a drawdown time of 48 hours. A 48-hour drawdown time has been used in preparing the nomograph and sizing equations in Appendix H.

The California BMP Method should be used to design volume-based stormwater treatment facilities in Contra Costa. Appendix H includes a nomograph and isohyetal maps to be used in determining the unit basin storage size.

► FLOW HYDRAULIC DESIGN BASIS FOR TREATMENT FACILITIES

The RWQCB permit allows three alternatives for calculating the peak flow rate that a continuous-flow treatment facility (e.g., a sand filter without an upstream detention area) must be able to accommodate.

All three use the rational method to calculate peak flows:

$$Q = C\, i\, A$$

where

Q = Peak flow rate (cubic feet per second)

C = Runoff coefficient (dimensionless)

i = Rainfall intensity (inches per hour)

A = Tributary area (acres)

The difference between the three methods is in the calculation of the design rainfall intensity, *i*.

The three alternatives are intensity-duration-frequency (IDF), percentile rainfall intensity, and 0.2 inches/hour.

The intensity-duration-frequency alternative requires that a time of concentration (T_c) be calculated for the tributary area. Calculation of a time of concentration is based on analysis of the time required for a hypothetical drop of water to flow from the furthest point of the watershed, overland and/or through pipes, to the BMP. Once T_c is determined, a corresponding *i* can be found from graphs of rainfall intensity vs. time from start of storm. The RWQCB permit specifies use of the rainfall intensity corresponding to a 50-year storm.

This method is most applicable to larger sites with overland drainage and relatively little impervious cover; however, the use of flow-based facilities (such as sand filters) in such sites is not recommended because of the potential for clogging the filter with fine sediments. Because calculation of T_c is complex and uncertain. Because the peak flow rate can be sensitive to T_c, the CCCWP has determined this method is not suitable for sizing stormwater treatment facilities in Contra Costa County.

The percentile rainfall intensity alternative is based on ranking the hourly depth of rainfall from storms over a relatively long record. The RWQCB permit specifies that the design rainfall intensity be equal or greater than the 85th percentile hourly depth multiplied by two.

The 0.2 inches/hour alternative simply specifies the required i : 0.2 inches per hour.

The CCCWP conducted an analysis of the various options and determined that 0.2 inches per hour is reasonably conservative and is applicable everywhere in Contra Costa County. This criterion should be used to design flow-based stormwater treatment facilities in Contra Costa.

The CCCWP used the 0.2 inches per hour criterion to develop a consistent countywide sizing factor for "dry" swales, planters, and bioretention areas when used for stormwater treatment only (i.e., not for flow control). The factor is based on facilities constructed with a specified sandy loam mix with an infiltration rate of at least 5 inches per hour. The sizing factor is the ratio of the rainfall intensity (0.2 inches/hour) to the infiltration rate (5 inches/hour), or 0.04 (dimensionless).

► STORMWATER TREATMENT EFFECTIVENESS CRITERIA

To comply with their stormwater NPDES permit, Contra Costa municipalities must require applicants for development approvals for projects subject to Provision C.3 to "design and implement stormwater treatment measures to reduce the discharge of stormwater pollutants to the maximum extent practicable." The CCCWP has determined* the following types of facilities can meet the "maximum extent practicable" standard for stormwater treatment effectiveness when designed using the criteria in this *Guidebook*:

- "Dry" swales, planter boxes, bioretention areas, and other facilities using filtration through soil or sand (sized with a surface area at least 0.04 times the effectively impervious tributary area).
- Dry wells, infiltration trenches, infiltration basins, and other facilities using infiltration to native soils (sized according to the volume-based criterion).
- Extended detention basins, constructed wetlands or other facilities using settling (sized according to the volume-based criterion, with a detention time of 48 hours).

Proprietary Devices
Most currently available proprietary devices do not meet the "maximum extent practicable" standard when used alone for stormwater treatment. Consult with municipal staff before proposing these devices.

Hydrodynamic separators, including vortex separators and continuous deflection separators ("CDS units"), are substantially less effective than any of the above-listed facilities for removing stormwater pollutants of concern.* When used as a sole method of stormwater treatment, hydrodynamic separators do not meet the "maximum extent practicable" requirement for stormwater treatment effectiveness with regard to compliance with NPDES Provision C.3 in Contra Costa, although they may be used in series with other facilities.

Regional Water Board staff has found oil/water separators ("water quality inlets") and storm drain inlet filters do not meet the "maximum extent practicable" standard.†

Underground vaults typically lack the detention time required for removal of pollutants associated with fine particles. They also require frequent maintenance and may retain stagnant water, potentially providing harborage for mosquitoes. Because vaults may be "out of sight, out of mind," experience shows that the required maintenance may not occur.

Many proprietary stormwater treatment devices are currently marketed, and new brands will be introduced. Applicants and applicants' engineers and design professionals should review with municipal staff any proposals for using proprietary devices for stormwater treatment before they commence work on preliminary site layout, drainage plans, grading plans, or landscape plans.

► FLOW-CONTROL (HMP) TECHNICAL CRITERIA

Appendix D contains the Contra Costa Clean Water Program's flow-control standard. A summary of the applicable criteria follows.

For projects subject to flow-control (HMP) requirements, runoff must not exceed pre-project runoff peaks and durations. In some cases, increased runoff may be allowed if it can be demonstrated there is minimal risk of downstream erosion.

Contra Costa's Hydrograph Modification Management Plan (HMP) provides applicants four options for compliance. The options and a summary of criteria follow. Guidance for documenting compliance begins on page 60.

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* *Policy on the Use of Hydrodynamic Separators to Achieve Compliance with NPDES Provision C.3*, November 16, 2005

† "Use of Storm Drain Inlet Filters and Oil/Water Separators to Meet the Requirements of NPDES Municipal Stormwater Permits," letter from Regional Water Board Executive Officer Bruce Wolfe to Bay Area Stormwater Management Agencies Association managers, August 5, 2004

Option 1. Demonstrate the project produces no net increase in impervious area. A simple inventory and accounting of existing and proposed impervious area is required.

Option 2. Implement IMPs such as planters, swales, and bioretention areas using the CCCWP's low-impact development site design procedure and facility sizing tool. Applicable criteria, including runoff factors and IMP sizing ratios, have been selected to meet the flow-control standard and are incorporated into the tool.

Option 3. Use a continuous-simulation hydrologic computer model such as USEPA's Hydrologic Simulation Program—Fortran (HSPF) to simulate pre-project and post-project runoff, including the effect of proposed IMPs, detention basins, or other storwmater management facilities. An hourly rainfall record of at least 30 years must be used.* Compile flow statistics and produce summary peak flow and flow duration graphics to demonstrate the following criteria are met:

> For flow rates from 10% of the pre-project 2-year runoff event (0.1Q2) to the pre-project 10-year runoff event (Q10), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10% over more than 10% of the length of the flow duration curve.
>
> For flow rates from 0.5Q2 to Q2, the post project peak flows shall not exceed pre-project peak flows. For flow rates from Q2 to Q10, post-project peak flows may exceed pre-project flows by up to 10% for a 1-year frequency interval. For example, post-project flows could exceed pre-project flows by up to 10% for the interval from Q9 to Q10 or from Q5.5 to Q6.5, but not from Q8 to Q10.

Option 4. Show that, because of the specific characteristics of the stream receiving runoff from the project site, or because of proposed channel restoration projects, or both, there is little likelihood the cumulative impacts from new development could increase the net rate of stream erosion significantly.

a. "Low Risk." Show all downstream reaches, from the project site to the Bay/Delta, are enclosed pipes, engineered hardened channels, subject to tidal action, or aggrading.

b. "Medium Risk." Use the CCCWP's methods and criteria (in Appendix D) to confirm each reach downstream from the project to the Bay/Delta meets criteria for the "medium risk" (or "low-risk") classification. Implement an in-stream

* Data files containing hourly rainfall records from six Contra Costa gauges are available from the Contra Costa Clean Water Program.

mitigation project to stabilize stream beds or banks, improve natural stream functions, and/or improve habitat values. The expected environmental benefits of the mitigation project must substantially outweigh the potential impacts of an increase in runoff from the development project.

c. "High Risk." Implement a comprehensive program of in-stream measures to improve stream channel hydrological and ecological functions while accommodating increased flows.

References and Resources

- Appendix D: *Flow Control*
- RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit Amendments) Provisions C.3.(b) and C.3.(j)
- RWQCB Order No. R2-2006-0050, revising hydrograph modification management (flow-control) requirements
- *California Stormwater Best Management Practice Handbooks* (SWQTF, 1993).
- *California Stormwater Best Management Practice Handbooks* (CASQA, 2003).
- *Urban Runoff Quality Management* (WEF/ASCE, 1998)
- *Hydrology Handbook, Second Edition* (ASCE, 1996)
- *Low Impact Development Design Strategies: An Integrated Approach* Chapter 3. (Maryland, 2001)
- *Policy on the Use of Hydrodynamic Separators to Achieve Compliance with Provision C.3* (CCCWP, 2005)

Part 2: Design and Documentation

There are two general approaches to managing site runoff.

1. The conventional approach collects site drainage and conveys it to one or a few facilities that retain, detain, or treat runoff. One facility receives drainage from the whole site, or a few facilities each serve large portions of the site. The facilities typically serve a mix of impervious, pervious, and partially pervious areas. They generally require frequent maintenance.

2. The Low Impact Development (LID) approach aims to maintain, as much as possible, the hydrological and ecological functions of the pre-developed site. LID design emphasizes dispersal, rather than concentration, of runoff. Detention areas, infiltration areas, and Integrated Management Practices (IMPs)—such as planter boxes, swales, and bioretention areas—are distributed throughout the site. The LID approach is also called the Start at the Source approach, as it is consistent with the design philosophy in BASMAA's *Design Guidance Manual for Stormwater Quality Protection* (1999).

The Contra Costa Clean Water Program recommends the Low Impact Development approach. LID was developed in Prince George's County, Maryland and other jurisdictions in response to maintenance, aesthetic, and safety problems associated with conventional treatment facilities. In general, IMPs distributed throughout the site look better and can be fit into setbacks and landscaped areas. IMPs are less likely to fail and are less likely to harbor mosquitoes or other vectors. Maintenance requirements may be little more than what is required for normal landscaping.

Detention and slow filtration through biologically active soil in the IMPs provides "maximum extent practicable" treatment effectiveness, increases the time of concentration of flow, reduces peak discharges, and controls flow durations.

The CCCWP has developed design criteria and sizing factors for seven IMPs:

- Flow-through Planter
- Infiltration Planter
- Bioretention Area
- Vegetated or Grassy "Dry" Swale
- Infiltration Basin
- Dry Well
- Infiltration Trench

Infiltration Basins, Dry Wells, and Infiltration Trenches may only be used Hydrologic Soil Group "A" or "B" soils. Planters, Swales, and Bioretention Areas can be used in "A" and "B" soils and may also be used in lower-permeability "C" and "D" soils if designed with a gravel underlayer and perforated pipe underdrain.

The IMPs may be used to comply with treatment requirements or—with upsizing and minor design changes—to comply with both treatment and flow-control (hydrograph modification management) requirements. See Appendix C.

► DESIGN AND DOCUMENTATION USING LOW-IMPACT DEVELOPMENT

LID design requires thoughtful, detailed design of grading and drainage and careful integration with site and landscaping designs.

To document that each IMP meets the C.3 minimum criteria, it is necessary to account separately for drainage to each IMP and show that each IMP is appropriately sized to receive runoff from that area.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

The CCCWP has developed the following recommended design procedure. The procedure results in a space-efficient, cost-efficient design for meeting C.3 requirements on most residential and commercial/industrial developments.

The procedure requires careful delineation of pervious areas and impervious areas (including roofs) throughout the site. The procedure accounts for how the runoff produced by each delineated area is treated, ensures each IMP is appropriately sized, and arranges documentation of IMP sizing in a consistent format for presentation and review.

The recommended design procedure is intended to facilitate, not substitute for, creative interplay among site design, landscape design, and drainage design. Several iterations may be needed to find the design with optimal aesthetics, circulation, and use of available area for your site.

A sizing tool is provided for making calculations and presenting them in your Stormwater Control Plan. See Appendix I. The sizing tool accommodates design for stormwater treatment only or for stormwater treatment plus flow control.

To begin using the sizing tool, first enter the project name, location, and Assessor's Parcel Number (APN). Then enter the total project area.

► DIVIDE THE SITE INTO DISCRETE DRAINAGE MANAGEMENT AREAS

This is the key first step. You must divide the entire project area into individual, discrete Drainage Management Areas. The Exhibit, tables, text, and calculations in your Stormwater Control Plan will illustrate, describe, and account for runoff from each of these areas.

Each drainage management area should be either entirely pervious or entirely impervious. As you delineate impervious drainage management areas, minimize the concentration of runoff and need for conveyance by distributing drainage from opposite sides of driveways, opposite sides of buildings, and from different sections of parking lots.

Assign each discrete drainage management area an identification number and determine its size (in square feet) and imperviousness (landscaped or paved/roofed).

Next, determine how drainage from each drainage management area will be handled. Each drainage management area will be one of the following four types:

1. Self-treating areas.

2. Self-retaining areas (also called "zero-discharge" areas).

3. Impervious areas draining to self-retaining areas.

4. Areas that drain to IMPs.

On most densely developed sites—such as commercial and mixed-use developments and small-lot residential subdivisions—most drainage management areas will drain to IMPs. Self-retaining and self-treating areas are more commonly used on sites with extensive landscaping. Each drainage area type is described below.

► 1. SELF-TREATING AREAS

Self-treating areas are landscaped or turf areas which do not drain to IMPs, but rather drain directly off site or to the storm drain system. Examples include upslope undeveloped areas which are ditched and drained around a development and grassed slopes which drain directly to a street or storm drain. In general, self-treating areas include no impervious areas, unless the impervious area is very small (5% or less) in relationship to the receiving pervious area and slopes are gentle enough to ensure runoff will be absorbed into the vegetation and soil.

Rationale

Pollutants in rainfall and windblown dust will tend to become entrained in the vegetation and soils of landscaped areas, so no additional treatment is needed. It is assumed the self-treating landscaped areas will produce runoff less than or equal to the pre-project site condition.

► 2. SELF-RETAINING AREAS

Where, because of site layout or topography, it is not possible to drain entirely pervious areas off-site separately, they can be made self-retaining by designing them to retain the first one inch of rainfall. The technique works on best on flat, heavily landscaped sites.

Runoff from self-retaining areas does not require any further treatment or flow control.

To create self-retaining turf and landscape areas in flat areas or on terraced slopes, berm the area or depress the grade into a concave cross-section so that these areas will retain the first inch of rainfall. Specify slopes, if any, toward the center of the pervious area. Inlets of area drains, if any, should be set 3 inches above the low point to allow ponding.

► 3. IMPERVIOUS AREAS DRAINING TO SELF-RETAINING AREAS

Runoff from impervious areas, such as roofs, can be managed by routing it to self-retaining pervious areas. The maximum ratio is 2 parts impervious area for every 1 part pervious area if only treatment requirements apply to the development project. If flow-control requirements also apply the maximum ratio is 1 part impervious area for every 1 part pervious area.

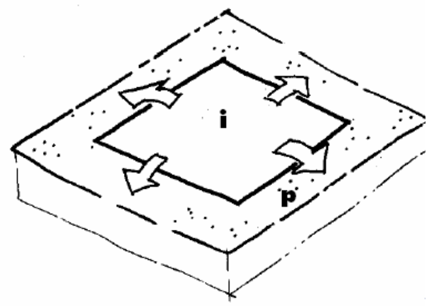

FIGURE 5-1. Relationship of impervious to pervious area for self-retaining areas.
Where flow-control requirements apply: $p \geq i$
Where only treatment requirements apply : $p \geq \frac{1}{2} i$
Figure from: Start at the Source.

The drainage from the impervious area must be directed to and dispersed within the pervious area, and the entire area must be designed to retain an inch of rainfall without flowing off-site. For example, if the maximum ratio of 2 parts impervious area into 1 part pervious area is used, then the pervious area must absorb 3 inches of water over its surface before over-flowing to an off-site drain.

Derivation of Criteria

A computer model was used to continuously simulate rainfall, infiltration, and runoff at an hourly time-step over 30 years. Results indicate drainage areas using the 1:1 ratio will not exceed pre-project peaks and durations.

Prolonged ponding is a potential problem at higher impervious/pervious ratios. In your design, ensure that the pervious area soils can handle the additional run-on and are sufficiently well-drained.

Under some circumstances, drainage management areas composed of **pervious pavement** (e.g., crushed stone, pervious asphalt, or pervious concrete) can be self-retaining areas. Adjacent impervious drainage management areas may drain on to the pervious pavement (in the same maximum ratios as described above) as long as it is assured the first one inch of rainfall over the entire self-retaining area will be captured and infiltrated rather than being allowed to run off. Ensure upgradient landscaped slopes are not excessively steep and are stabilized so sediment from landscaped or undeveloped areas does not wash on to the pervious pavement and cause clogging. A gravel base course four or more inches deep will ensure an adequate proportion of rainfall is infiltrated into native soils (including clay soils) rather than producing runoff. The base course should not be underdrained. Consult with a qualified geotechnical engineer regarding infiltration rates, pavement stability, and suitability of the installation for the intended traffic.

► 4. DRAINAGE MANAGEMENT AREAS DRAINING TO IMPS

These areas are used to calculate the required size of the IMP. The CCCWP has developed sizing factors (ratios of IMP area to tributary area). Sizing factors are accessed via the CCCWP's IMP sizing tool, which applies the sizing factor and calculates the required IMP surface area.

More than one drainage area can drain to the same IMP. However, because the minimum IMP sizes are determined by ratio to drainage area size, a drainage area may not drain to more than one IMP. See Figures 5.2 and 5.3.

Where possible, design site drainage so only impervious roofs and pavement drain to IMPs. This yields a simpler, more efficient design and also helps protect IMPs from becoming clogged by sediment.

If it is necessary to include turf, landscaping, or pervious pavements within the area draining to an IMP, list each surface as a separate drainage management area. A runoff factor (similar to a "C" factor used in the rational method) is applied to account for the reduction in the quantity of runoff. For example, when a turf or landscaped drainage management area drains to an IMP, the resulting increment in IMP size is:

(pervious area) × (runoff factor) × (sizing factor).

Factors for various surfaces are incorporated into the sizing tool.

► USING THE SIZING TOOL FOR LOW IMPACT DEVELOPMENT DESIGN

Download the sizing tool from the CCCWP C.3 web page at http://www.cccleanwater.org/construction/nd.php.

To use the tool, begin by marking up a preliminary site plan or grading and

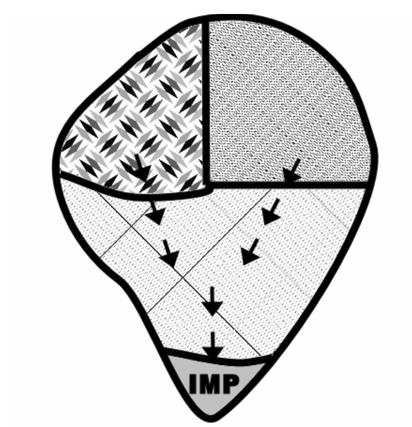

FIGURE 5-2. MORE THAN ONE
Drainage Management Area can drain to a single IMP.

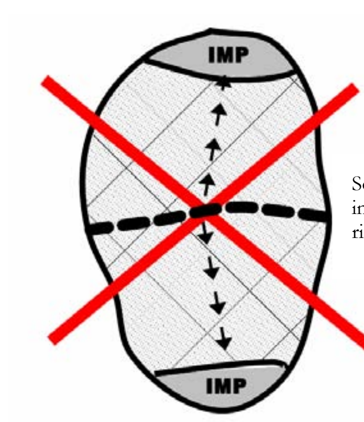

FIGURE 5-3. ONE DRAINAGE
Management Area cannot rain to more than one IMP.

drainage plan. Delineate drainage management areas and identify each area as self-treating, self-retaining, draining to a self-retaining area, or draining to an IMP. Assign a unique identification number to each delineated area and determine the square footage of each.

Follow the instructions in the sizing tool help file to select IMPs and determine the required minimum IMP sizes. Incorporate the sizing tool output in your Stormwater Control Plan.

► SIZING CONVENTIONAL STORMWATER TREATMENT FACILITIES

As described in the RWQCB permit, treatment facilities are either volume-based or flow-based. For some volume-based conventional treatment facilities (e.g., detention basins and constructed wetlands) discharge is controlled by the design of the outlet structure, including size and placement of the outlet orifices. Extended (dry) detention basins seem to work best and are least prone to problems when designed to serve areas of 20 acres or more.

Appendix H includes an isohyetal map and nomograph which may be used to size detention basins and constructed wetlands for stormwater treatment in accordance with the California BMP method.

If your project is also subject to flow-control requirements, a combined treatment/flow duration control basin may be more efficient than separate facilities for treatment and flow control.

Local Requirements

Some Contra Costa municipalities may consider allowing a higher infiltration rate for projects smaller than an acre with "zero lot line" style development in pedestrian-oriented downtowns. The higher infiltration rate may also apply on portions of project sites which are not being developed but which must be retrofit under the "50% rule." See Appendix A and check with local planning and community development staff.

To size flow-based treatment facilities, such as swales and media filters, first determine the design flow rate from area tributary to the facility using the rational formula. The specified rainfall intensity is 0.2 inches/hour. The "C" factors in Table 5-1 may be used.

Next, add the flows from each area to determine the total design flow for the facility.

Filtration facility must be designed to accommodate this flow continuously. To calculate the minimum required filter surface area, use a filtration rate of 5 inches/hour or less.

► SIZING CONVENTIONAL FLOW-CONTROL FACILITIES

As described in Option 3 of the CCCWP's flow-control standard, you may use a continuous simulation hydrologic computer model such as USEPA's Hydrograph Simulation Program—Fortran (HSPF) to size and demonstrate the effectiveness of conventional flow-control facilities. Continuous simulation hydrologic

TABLE 5-1. RUNOFF FACTORS* to be used for design of conventional treatment-only facilities

Surface	*Runoff Factor "C" (treatment-only facilities)*
Roofs	1.0
Conventional Concrete or Asphalt Paving	1.0
Pervious Concrete or Asphalt (over a minimum 4-inch base course)	0.1
Grouted unit pavers	1.0
Unit Pavers (brick, stone, or cast) on sand, set tight	0.8
Unit Pavers on sand, minimum ⅜" gap between pavers	0.3
Crushed Aggregate	0.1
Grass or Landscaping	0.1

modeling can also be used to evaluate the effects of IMPs or other stormwater management facilities as an alternative to using the sizing tool. Compliance with flow-control requirements is based on a comparison of pre-project to post-project model output for a rainfall record of at least 30 years.

Appendix D includes guidance for modeling the project site and using HSPF to simulate runoff. Sizing facilities to meet the peak flow and duration control standard is typically an iterative process including the followings steps:

1. Use long-term simulations to compute hourly runoff hydrographs for the site in its pre-project condition, for the proposed project, and for the proposed project with flow-control facilities.

2. Calculate peak flow frequencies using partial duration series statistics.

3. Calculate flow duration statistics.

4. Produce summary peak flow and flow-duration graphics to assess the performance of the flow-control facilities.

Figures 5-4 and 5-5 illustrate results that meet the standards for peak flow control and duration control, respectively. Note the mitigated peak flow and mitigated durations are below the estimated pre-project peak flows and durations.

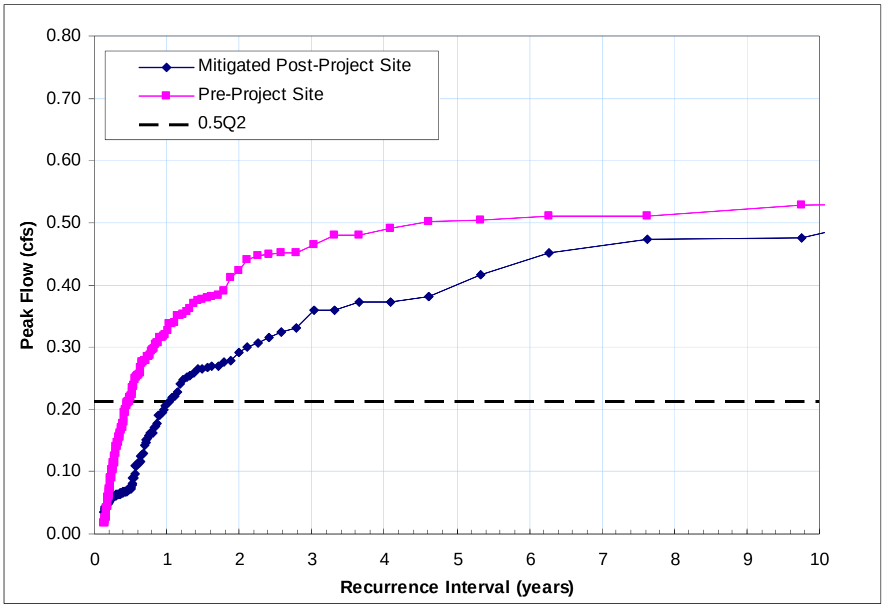

FIGURE 5-4. EXAMPLE OF GRAPHIC OUTPUT demonstrating compliance with the peak flow standard.

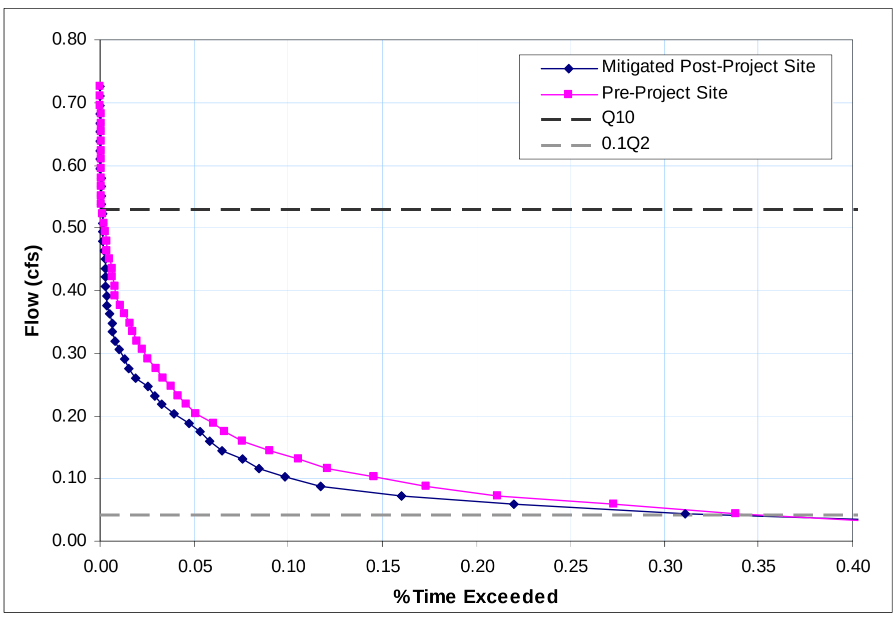

FIGURE 5-5. EXAMPLE OF GRAPHIC OUTPUT demonstrating compliance with the flow duration control standard.

References and Resources

- Appendix D: Flow Control
- RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit Amendments) Provision C.3.(d)
- RWQCB Order No. R2-2006-0050, revising hydrograph modification management (flow-control) requirements
- *Start at the Source* (BASMAA, 1999).
- *Using Site Design Techniques to Meet Development Standards for Stormwater Quality* (BASMAA, 2003).
- *Hydrology Handbook, Second Edition* (ASCE 1996)
- *Portland Stormwater Management Manual* (City of Portland, 2004).
- *USDA SCS Technical Release TR55*, Appendix A: Soil Types

Part 3: Design Ideas and Resources

► SITE DESIGN AND SELF-RETAINING AREAS

Start at the Source: Design Guidance Manual for Stormwater Quality Protection, published in 1999 by the Bay Area Stormwater Management Agencies Association (BASMAA), is an updated version of a manual first published in 1997. The 1999 edition covers planning and zoning, site design, and drainage systems. The manual also includes some details for site design, pervious pavements and landscaping, and BMPs.

Start at the Source is an excellent general design guide and is best consulted at the beginning of the site design process.

In 2003, BASMAA produced a companion guide, *Using Site Design Techniques to Meet Development Standards for Stormwater Quality.* The definitions and descriptions of "zero discharge" (self-retaining) areas, self-treating areas, and use of runoff factors are the same as in this *Stormwater C.3 Guidebook*. BASMAA's 2003 guide, however, assumes a conventional detention basin or other facility will serve the whole project, rather than (as is recommended here) locating IMPs throughout the site to serve individually delineated drainage areas.

► SELECTING AND DESIGNING IMPS

Attachment C-1 to Appendix C contains ten Fact Sheets covering site design practices, indirect infiltration practices, and direct infiltration practices.

The fact sheets include general information, illustrations, and design checklists as well as design details.

The fact sheets cover a wide range of options suitable for different site conditions and types of development in Contra Costa County. Consult Table 5-2 for an initial selection of options which may be suitable to your site.

The fact sheets are provided to assist you with developing a Stormwater Control Plan. Additional drawings and specifications, showing construction materials and methods to be used, plumbing connections, etc., may be required with your application for a building permit. Check with the local Building Department for requirements that apply to your project.

The Prince George's County, Maryland *Bioretention Manual* provides excellent advice on all aspects of designing, constructing, and maintaining bioretention facilities.

► DESIGN OF CONVENTIONAL TREATMENT FACILITIES

For guidance on designing constructed wetlands or detention basins, see *Urban Runoff Quality Management* (WEF/ASCE, 1998) and the *California Stormwater BMP Handbooks* (CASQA, 2003). Chapter 3 of the *Maryland Stormwater Design Manual* (Maryland Department of the Environment, 2000) is another good resource.

► DESIGN OF CONVENTIONAL FLOW-CONTROL FACILITIES

For ideas for the design of outlets for flow-duration control basins, see the Santa Clara Valley Urban Runoff Pollution Prevention Program's *Hydromodification Management Plan, Appendix F, Flow Duration Basin Design Guidance.*

► MISCELLANEOUS NOTES AND DESIGN ADVICE

The following notes and design advice have been compiled from observations and experience with the design of treatment and flow-control facilities for development sites and from the Contra Costa Clean Water Program's Vector Control Plan. Review these notes and incorporate applicable items into your Stormwater Control Plan. This will help ensure that these concerns are addressed in the final design and construction permit review process.

- IMPs or conventional facilities will require 1 to 4 feet or more head (difference in elevation between the inlet and outlet). Note that in some cases outlets can be piped to underground storm drain systems. Wherever possible, locate and design the facility along the hydraulic grade line of the site drainage. Vaults, pumps, and sumps are strongly discouraged because they reduce reliability, increase maintenance, and create potential vector problems.

- Distribution of IMPs throughout the site is particularly important in flat areas where there is insufficient head to convey runoff via underground pipes. Direct runoff from parking and circulation areas via sheet flow or valley gutters to swales, infiltration planters, or bioretention areas located in medians or setbacks.

- Runoff from hillside developments can be collected and conveyed to swales or planter boxes on terraces or at the bottom of the site.

TABLE 5-2. IDEAS FOR APPLYING IMPs
included in the Fact Sheets in Appendix C

Site Features and Design Objectives	*Green Roofs*	*Downspouts & Cisterns*	*Grading, Paving, & Land-scaping*	*Flow-through Planter*	*Infiltration Planter*	*Bio-retention Area*	*Vegetated or Grassy Swale*	*Infiltration Basin*	*Dry Well*	*Infiltration Trench*
Clayey native soils	✓	✓	✓	✓	✓	✓	✓			
Permeable native soils	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Very steep slopes	✓			✓						
Shallow groundwater	✓	✓	✓	✓	✓	✓	✓			
Avoid saturating subsurface soils	✓		✓	✓						
Connect to roof downspouts		✓		✓	✓				✓	
Parking lots/islands and medians			✓		✓	✓	✓			
Sites with extensive landscaping		✓	✓			✓	✓	✓		
Densely developed sites with limited space/landscape	✓		✓	✓	✓				✓	✓
Fit BMPs into landscape and setback areas		✓			✓	✓	✓			✓
Make drainage a design feature		✓	✓			✓	✓			
Convey as well as treat stormwater							✓			

- Small (20 lots or fewer) subdivisions pose the most difficult challenge for planning operation and maintenance of IMPs in perpetuity. There may be too few property owners to support the administrative costs of a homeowners association, and the local municipality may be unwilling to take on maintenance, even if it is possible to establish or extend a special district for the purpose. Begin discussing IMP operation and maintenance at the earliest pre-application meeting.

- To avoid mosquito problems, the California Department of Health Services recommends that dry basins (extended detention basins) should be designed to drain completely within 72 hours of a rainfall. In many cases, it is acceptable in Contra Costa County to allow a maximum of five days for complete drainage.

- Large, shallow basins with gentle side slopes are easiest to maintain and may be designed as multi-use facilities (e.g. playing fields or landscape). Design extended detention basins with a sloped bottom channel to promote complete drainage. Consider over-excavating and replacing the detention-basin bottom with permeable soil and an underdrain to ensure complete drainage.

- Design and construct inlets and outlets to avoid differential settlement that can cause shallow, persistent puddles. Riprap or rock may be required to dissipate energy at inlets and outlets, but can collect standing water and create mosquito problems. Use cemented rock or ensure that any areas where water may temporarily pool are well-drained.

► OTHER DESIGN RESOURCES

Links to additional BMP design resources are on the Contra Costa Clean Water Program's C.3 web page at www.cccleanwater.org/construction/nd.php.

Chapter

6

Maintenance of Treatment and Flow-Control Facilities

Plan for the maintenance in perpetuity of the facilities being installed on your site.

Treatment and flow-control facilities must be regularly maintained to ensure that they continue to be effective and that they do not cause flooding, harbor vectors, or otherwise cause a nuisance.

NPDES Permit Provision C.3.e requires Contra Costa municipalities to periodically verify operation and maintenance (O&M) of the facilities installed in their jurisdiction. Each year, they must report to the Water Board the facilities they have inspected that year and the status of each.

The facilities you install as part of your project will be incorporated into your municipality's operation and maintenance verification program. This is a six-stage process:

1. Determine who will own the facility and be responsible for its maintenance in perpetuity.

2. Identify typical maintenance requirements, integrate these requirements into project planning and preliminary design, and document them in the Stormwater Control Plan. The Stormwater Control Plan must also identify any title transfers or maintenance agreements that will be executed before construction is complete.

3. Develop an Operation and Maintenance Plan for the site incorporating detailed requirements for each treatment and flow-control facility. This operation and maintenance plan must be

submitted before the building permit is final and a certificate of occupancy is issued. With submittal of the operation and maintenance plan, execute any required agreements.

4. Maintain the facilities from the time of construction until ownership and maintenance responsibility is formally transferred.

5. Formally transfer operation and maintenance responsibility to the site owner or occupant.

6. Maintain the facilities in perpetuity and comply with your municipality's self-inspection, reporting, and verification requirements.

TABLE 6-1. SCHEDULE for planning operation and maintenance of stormwater treatment BMPs.

Step	*Description*	*Where documented*	*Schedule*
1	Determine facility ownership and maintenance responsibility	Stormwater Control Plan	Discuss with planning staff at pre-application meeting
2	Identify general maintenance requirements	Stormwater Control Plan	Submit with planning & zoning application
3	Develop detailed operation and maintenance plan	O&M Plan	Submit draft with Building Permit application; final due before applying for a Certificate of Occupancy
4	Interim operation and maintenance of facilities	As required by municipal O&M verification program	During and following construction
5	Formal transfer of operation & maintenance responsibility	As required by municipal O&M verification program	On sale and transfer of property or permanent occupancy
6	Ongoing maintenance and compliance with inspection & reporting requirements	As required by municipal O&M verification program	In perpetuity

Step 1: Responsibility for Facility Maintenance

Ownership and maintenance responsibility for treatment and flow-control facilities should be discussed at the initial stages of project planning, typically at the pre-application meeting for planning and zoning review.

► PRIVATE OWNERSHIP AND MAINTENANCE

Typically, treatment and flow-control facilities that serve a single commercial, industrial, multi-family residential, or multi-use parcel will be built on that parcel and will be maintained in perpetuity by the property owner.

The municipality may require, as a condition of project approval, that a maintenance agreement to be executed or a permit to operate the stormwater facility be obtained. In either case, the municipality may require an annual fee to offset the cost of inspecting the site to verify that the facility is being maintained. Alternatively, the municipality may rely on its existing authorities (including its stormwater pollution prevention ordinance) to require ongoing maintenance of privately owned treatment and flow-control facilities.

The Contra Costa Clean Water Program recommends that applicants and municipalities consider carefully the potential consequences of locating treatment and flow-control facilities on new private residential lots. This arrangement would require a municipality to verify that homeowners were maintaining their facilities in perpetuity (and to take enforcement action if they have not been adequately maintained). The CCCWP also recommends against maintenance of facilities by homeowners associations or other private associations, because the private association may cease to exist at some point, while the municipality will always retain regulatory liability to ensure that the facility is maintained. However, individual municipalities may find specific circumstances where private ownership and maintenance of facilities in single-family residential areas are acceptable. On some lots it may be possible to use self-retaining areas (see page 63) instead of treatment and flow-control facilities.

► TRANSFER TO PUBLIC OWNERSHIP

In subdivisions, municipalities may sometimes choose to have a facility deeded to the public in fee or as an easement. In that case, the municipality maintains the treatment and flow-control facility as part of the municipal storm drain system. The municipality may recoup the costs of maintenance through a special tax, assessment district, or similar mechanism.

The need to locate a treatment and flow-control facility in a public right-of-way or easement creates an additional design constraint—along with hydraulic grade, aesthetics, landscaping, and circulation. However, because sites typically drain toward the street, it may be possible to locate a swale or similar IMP parallel with the edge of the parcel. The swale may complement, or substitute for, an underground storm drain system.

Even if the facility is to be conveyed to the municipality after construction is complete, it is still the responsibility of the builder to identify general operation and maintenance requirements, prepare a detailed operation and maintenance plan, and to maintain the facility until that responsibility is formally transferred.

Step 2: Typical Maintenance Requirements

Following are general maintenance requirements for typical treatment facilities, including those featured in the fact sheets in Appendix C.

You can use this information to prepare your Stormwater Control Plan.

► SWALES AND BIORETENTION AREAS

These facilities remove pollutants primarily by filtering runoff slowly through an active layer of soil. Routine maintenance is needed to ensure that flow is unobstructed, that erosion is prevented, and that soils are held together by plant roots and are biologically active. Typical maintenance consists of the following:

- Inspect inlets for channels, exposure of soils, or other evidence of erosion. Clear any obstructions and remove any accumulation of sediment. Examine rock or other material used as a splash pad and replenish if necessary.
- Inspect outlets for erosion or plugging.
- Inspect side slopes for evidence of instability or erosion and correct as necessary.
- Observe soil at the bottom of the swale or filter for uniform percolation throughout. If portions of the swale or filter do not drain within 48 hours after the end of a storm, the soil should be tilled and replanted. Remove any debris or accumulations of sediment.
- Confirm that check dams and flow spreaders are in place and level and that channelization within the swale or filter is effectively prevented.
- Examine the vegetation to ensure that it is healthy and dense enough to provide filtering and to protect soils from erosion. Replenish mulch as necessary, remove fallen leaves and debris, prune large shrubs or trees, and mow turf areas. When mowing, remove no more than ⅓

height of grasses. Confirm that irrigation is adequate and not excessive. Replace dead plants and remove noxious and invasive vegetation.

- Abate any potential vectors by filling holes in the ground in and around the swale and by insuring that there are no areas where water stands longer than 48 hours following a storm. If mosquito larvae are present and persistent, contact the Contra Costa Mosquito and Vector Control District for information and advice. Mosquito larvicides should be applied only when absolutely necessary and then only by a licensed individual or contractor.

► PLANTER BOXES

Planter boxes capture runoff from downspouts or sheet flow from plazas and paved areas. The runoff briefly floods the surface of the box and then percolates through an active soil layer to drain rock below. Typical maintenance consists of the following:

- Examine downspouts from rooftops or sheet flow from paving to ensure that flow to the planter is unimpeded. Remove any debris and repair any damaged pipes. Check splash blocks or rocks and repair, replace, or replenish as necessary.

- Examine the overflow pipe to make sure that it can safely convey excess flows to a storm drain. Repair or replace any damaged or disconnected piping.

- Check the underdrain piping to make sure it is intact and unobstructed.

- Observe the structure of the box and fix any holes, cracks, rotting, or failure.

- Check that the soil is at the appropriate depth to allow a reservoir above the soil surface and is sufficient to effectively filter stormwater. Remove any accumulations of sediment, litter, and debris. Till or replace soil as necessary. Confirm that soil is not clogging and that the planter will drain within 3-4 hours after a storm event.

- Determine whether the vegetation is dense and healthy. Replace dead plants. Prune or remove any overgrown plants or shrubs that may interfere with planter operation. Clean up fallen leaves or debris and replenish mulch. Remove any nuisance or invasive vegetation.

► INFILTRATION TRENCHES AND DRY WELLS

Infiltration trenches and dry wells store runoff and allow it to infiltrate into native soil. The primary objective of maintenance is to avoid entry of fine sediments which may clog the soil interface. Typical inspection and maintenance tasks include the following:

- Inspect periodically and following major storms. Remove any accumulated trash or sediment.
- Clean out sediment traps and pre-filters.
- Check observation wells 2-3 days after storms to confirm drainage.
- Repair any erosion at inflow or overflow structures.
- Mow and trim vegetation around the trench or dry well.

Upon failure (when the device fails to drain within 72 hours) the trench or dry well must be renovated. Typically this requires removal of rock fill and accumulated sediment, scarification of the bottom, replacement of filter fabric, and refilling the trench or dry well with clean rock fill.

► WET, EXTENDED WET DETENTION, DRY DETENTION, & INFILTRATION BASINS

These larger-scale facilities remove pollutants by detaining runoff in a quiescent pool long enough for some of the particulates to settle to the bottom. They require both routine (preventative) maintenance and non-routine maintenance.

For any basin, vault or other device that is designed to hold, or does hold water for longer than 72 hours, the following will typically be required:

- A copy of the O&M plan must be provided to the Contra Costa Mosquito and Vector Control District (CCMVCD).
- Access to all potential vector-producing areas will be given to CCMVCD personnel.
- Copies of O&M reports will be supplied to CCMVCD.
- The CCMVCD will be given advance notice of O&M activities such as silt management, vegetation management, and water management.
- A schedule of routine O&M activities will be given to the CCMVCD.
- O&M personnel will cooperate with CCMVCD and adjust activities as necessary to facilitate control of mosquitoes and vectors.

Typical routine maintenance consists of the following:

- Examine inlets to ensure that piping is intact and not plugged. Remove accumulated sediment or debris near the inlet.

- Examine outlets and overflow structures and remove any debris or sediment that could plug the outlets. Identify and correct any sources of sediment and debris. Check rocks or other armoring and replace as necessary.

- Inspect embankments, dikes, berms, and side slopes for signs of erosion or structural deficiencies.

- Confirm that any fences around the facility are secure.

- Control vectors by filling any holes in or around the pond and examine the pond for evidence of mosquito larvae.

Typical non-routine maintenance includes the following:

- Dredge accumulated sediment. This may be required every five to 15 years, and more frequently if there are excess sources of sediment (as may occur on newly constructed sites where soils are not yet stabilized). Dredging is usually a major project requiring mechanized equipment. The work will include an initial survey of depths and elevations; sediment sampling and testing; removal, transport, and disposal of accumulated sediment, and reestablishment of original design grades and sections.

- Remove invasive plants. Depending on the success of the design and the rate of sedimentation, ponds may be subject to excessive growth of rooted macrophytes, which reduce the effective area of the pond and create quiescent surface water that supports mosquito larvae. Removal may require a level of effort similar to dredging.

Step 3: Stormwater Control O&M Plan

After the construction drawings and specifications for your stormwater treatment and hydrograph modification facilities have been completed, prepare a Stormwater Control Operation and Maintenance (O&M) plan.

The O&M plan may be simple or complex depending on the type of facilities selected and implemented for your project. For example, scheduled maintenance for landscape detention areas may require little more explanation than irrigation cycles, plant care, and observation of any drainage problems. In contrast, a system with pumps and sumps should incorporate manufacturer's maintenance recommendations, warranty information, detailed operating plans, and a seasonal schedule for inspections. Wet ponds or constructed wetlands will require detailed O&M plans to monitor and, if necessary, abate problems with mosquitoes or excessive macrophyte growth. In addition, it may be advisable to manage wet ponds or wetlands to avoid designation as critical habitat for endangered species.

Appendix F provides instructions for the preparation of O&M plans. Example Stormwater Control Operation and Maintenance Plans are in Appendix J.

Step 4: Interim Operation & Maintenance

In accordance with Provision C.3.e.ii. of the Stormwater NPDES permit, the project proponent must provide a signed statement "accepting responsibility for maintenance [of stormwater treatment facilities] until the responsibility is transferred to another entity.…" Include a statement to this effect in your Stormwater Control Plan.

The detailed O&M plan should incorporate solutions to any problems noted or changes that occurred during construction. For this reason, the detailed O&M plan may be submitted at the end of the construction period, before the application for final building permit and Certificate of Occupancy.

Step 5: Transfer Responsibility

As part of the detailed O&M plan, note the expected date when responsibility for operation and maintenance will be transferred. Notify your municipality when this transfer of responsibility takes place.

Step 6: Operation & Maintenance Verification

Each Contra Costa municipality will implement a Stormwater Treatment Measures Operation and Maintenance Verification Program, including periodic site inspections. The local verification program is described in Appendix K.

References and Resources

- *Appendix F, Preparing Your Stormwater Control Operation and Maintenance Plan*
- *Model Stormwater Ordinance (CCCWP, 2005)*
- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- *Stormwater Management Manual* (Portland, 2004). Chapter 3.
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003).
- *Best Management Practices Guide* (Public Telecommunications Center for Hampton Roads, 2002).
- Contra Costa Clean Water Program *Vector Control Plan*
- Operation, Maintenance, and Management of Stormwater Management Systems (Watershed Management Institute, 1997)

Chapter

7

Alternative Compliance Options

Alternatives for meeting stormwater control requirements for your site by participating in a regional stormwater facility, by implementing compensatory mitigation, or obtaining an exemption.

Contra Costa municipalities may establish an alternative compliance program or, in the absence of such a program, allow a particular project to implement "alternative compliance" in lieu of incorporating stormwater treatment BMPs into their project.

Under certain conditions, a project applicant may choose to reduce or omit treatment BMPs from their project design. Instead, applicants may create an equivalent water-quality benefit at a different site. Where feasible, this site should be in the same drainage basin.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A and check with local planning and community development staff.

Other C.3 requirements—including site designs to minimize imperviousness and structural and operational source control BMPs—will still apply.

The Contra Costa Clean Water Program recommends that you follow the steps in Chapter 3 to prepare a Stormwater Control Plan for your project before considering options for alternative (off-site) compliance.

Should an alternative compliance option be necessary, the Stormwater Control Plan for your project site is still needed to detail how site design measures, source control BMPs and other remaining on-site requirements will be met and will also help establish that on-site treatment measures are infeasible or impracticable, if that is the case.

"Alternative compliance" may be implemented by pursuing any of the following three options:

1. Participate in a regional stormwater treatment facility.

2. Demonstrate the impracticability of incorporating treatment BMPs on your development site and also demonstrate how you will provide compensatory mitigation (equivalent treatment or equivalent water-quality benefit) at another site.

3. Obtain an exemption from the requirements if impracticability of incorporating treatment BMPs on your site can be established, the costs of participating in a regional facility or implementing compensatory mitigation at another site would "unduly burden" the project, and the project is a redevelopment project that also meets certain categorical criteria established by the Water Board.

Provision C.3.g of the stormwater NPDES permit details the Water Board's requirements for "alternative compliance."

Local planning and engineering staff can provide up-to-date information on your municipality's proposed "alternative compliance" program or requirements and how they might apply to your project.

References and Resources

- San Francisco Bay RWQCB Order No. R2-2003-0022 (Stormwater NPDES Permit C.3 Amendment), Provision C.3.g

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Appendix

A

Local Exceptions & Requirements

Municipality-specific procedures, policies, and submittal requirements.
Obtain from your municipal planning department.

The Contra Costa Clean Water Program C.3 web page includes links to each Contra Costa municipality's C.3 information.

Appendix

B

Plant List

Plants Suggested for Consideration for Planter Boxes, Swales, and Bioretention Areas

Planting plans for projects in Contra Costa County have shown the following species located in planter boxes, swales, or bioretention areas.

It has also been suggested that the plant suggestions in East Bay Municipal Utility District's book, *Plants and Landscapes for Summer-Dry Climates*, may be suitable for planter boxes, swales, and bioretention areas.

No representation is made regarding the suitability of any selection for any particular location or condition. A qualified landscape architect should be consulted.

► BACKGROUND SHRUBS

Dodonea viscosa "Saratoga" – Purple Hop Bush
Photinia Fraseri – Red Leaf Phontinia
Fremontedendron "California Glory" – California Glory Flannel Bush

► FOREGROUND SHRUBS

Arbutus unedo "Compacta"
Abelia "Edward Goucher" – Edward Goucher Abelia
Abelia grandiflora – Abelia spp.
Rhaphiolepis indica "Jack Evans" – Jack Evans India Hawthorn
Escallonia rubra "Fradesii"

► ACCENT SHRUBS

Agapanthus africanus “Peter Pan” – Peter Pan Lily-of-the-Nile
Cistus spp. – Rockrose
Correa pulchella – Australian Fushsia
Gardenia jasminoides “Veitchii” – Dwarf Gardenia
Helianthemum nummularium – Sunrose
Hemerocallis spp. – Daylily (ass't varieties)
Lavandula angustifolia “Munstead” – English Lavender
Moraea iridioides – Fortnight lily
Pittosporum tobira “Wheeler's Dwarf” – Wheeler's Dwarf
Raphiolepis indica “Ballerina” – Dwarf India Hawthorn
Mahonia aquifollum “Compacta” – Dwarf Oregon Grape Holly

► GROUNDCOVER

Arctostaphylos “Emerald Carpet” – Emerald Carpet
Manzanita Cotoneaster dammeri – Bearberry Cotoneaster
Hypericum moseranium – Gold Flower
Juniperus h. “Blue Chip” – Blue Chip Juniper
Juniperus s. “Buffalo” – Buffalo Juniper
Rosmarius officialis “Prostratus” – Rosemary
Tachelospermum jasminoides – Star Jasmine

Appendix

C

Stormwater Infiltration Guidelines

How to select feasible and effective stormwater infiltration systems for your development site.

Infiltration can be the most cost-effective method to manage stormwater—if conditions on your site allow.

Site planning and site grading can minimize runoff and promote infiltration on most sites. Planters, swales, and bioretention areas can be used on sites with native clay soils—if the devices are built with imported soils and underdrains. Where native soils are more permeable, infiltration basins, infiltration trenches, or dry wells may be used, if the devices are designed to protect groundwater quality.

Read this appendix for an overview of when, where, and how stormwater infiltration is feasible. "Rules of thumb" and matrices will help you determine which of the various methods work best on your site.

Appendix C Contents

The Program has also assembled fact sheets, including sample designs, for the most widely used infiltration systems. See Attachment C-1.

What is Stormwater Infiltration?

As a stormwater management method, infiltration means **retaining or detaining water within soils** to reduce runoff.

There are three possible routes from rainfall to stream flow (Figure C-1):

1. Rainfall on impervious surfaces becomes runoff and is almost immediately conveyed to streams via pipes or open channels. The relatively small amount that wets surfaces or is caught in small depressions is called initial abstraction.

2. Some rainfall on pervious areas enters soil pores and increases the soil moisture content. The soil continues to absorb some or all rainfall—depending on rainfall intensity and soil characteristics—until it becomes saturated and any additional rainfall becomes runoff. On slopes, absorbed water may seep from surface soils and become runoff or streamflow.

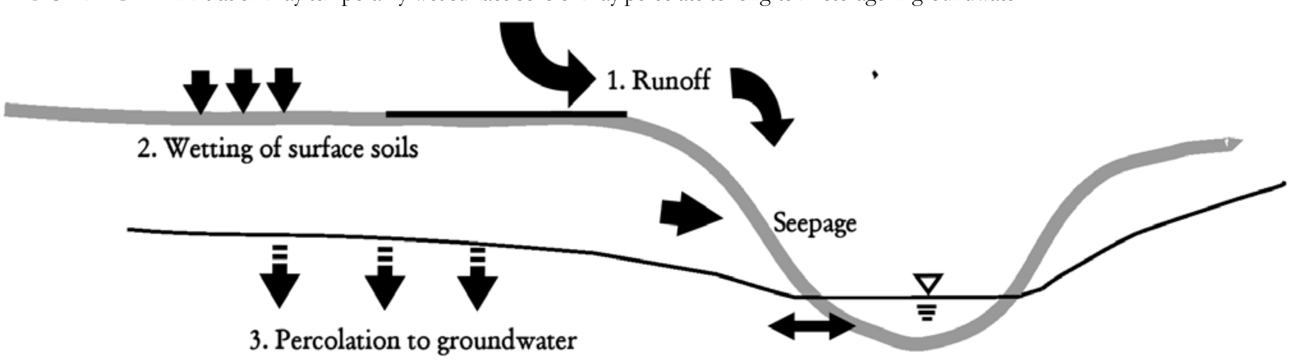
3. Some moisture percolates downward to the water table where it enters groundwater (deep infiltration). Groundwater may be stored for months or years and may migrate through aquifers to emerge as surface flow some distance away.

In undeveloped areas, the proportion of total rainfall that follows each of these routes depends on rainfall frequency, rainfall intensity, soil characteristics, vegetation, and slopes.

Typically, land development covers formerly pervious areas with roofs and pavement. In addition, vegetation may be removed and soils may be compacted. All of these changes tend to increase surface runoff and decrease infiltration to soils and groundwater. The increased intensity and duration of runoff transports more pollutants and also may erode and destabilize stream beds and banks.

These effects can be partially mitigated by enhancing stormwater infiltration. The

FIGURE C-1. Infiltration may temporarily wet surface soils or may percolate to long-term storage in groundwater.



LID approach to NPDES permit compliance is based on enhancing stormwater infiltration through site design and other methods designed to meet the C.3 permit provisions. The design procedure described in Chapter Five of the Guidebook emphasizes the use of site design and Integrated Management Practices (IMPs), which include direct and indirect infiltration devices, to meet stormwater treatment and flow control requirements.

Stormwater Infiltration Methods

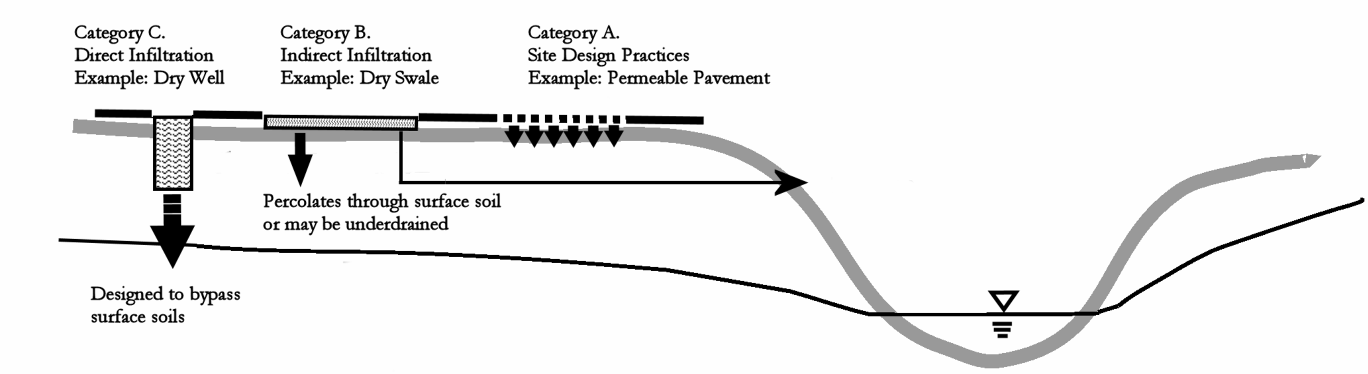
Stormwater infiltration methods may be categorized as follows (Figure C-2):

A. **Site design practices** which, while having a significant effect on runoff and infiltration, are very much integrated into the overall process of land development. These practices include laying out the site to reduce impervious area, routing drainage from building roofs to landscaped areas, and selecting of surface treatments when designing site grading and paving. Site design practices must be integrated with the site's urban design, architecture, landscape architecture, and engineering as part of a multifaceted design solution.

B. **Indirect infiltration** methods, including swales and bioretention areas. These features are expressly designed to hold runoff and allow it to percolate into surface soils. Runoff may reach groundwater indirectly, or may be underdrained into subsurface pipes.

C. **Direct infiltration** methods, which are designed to bypass unsaturated surface soils and transmit runoff directly to groundwater. Devices must be located and designed to limit the potential for stormwater pollutants to reach groundwater. Direct infiltration methods include dry wells and infiltration trenches.

FIGURE C-2. Stormwater Infiltration Methods: (A) Site Design Practices, (B) Indirect Infiltration, and (C) Direct Infiltration



Specific infiltration methods, including site design practices and both direct and indirect infiltration Integrated Management Practices (IMPs) are summarized in Table C-1 and discussed below. "Fact sheets" for some methods, including

TABLE C-1. Description of specific infiltration methods and facilities.

Method / Facility	*Description*
A. Site Design Practices	
Site Layout Practices	Examples: Concentrate development on least sensitive portions of the site; preserve pervious soils and natural drainage features; minimize the amount of impervious area by using shared parking, efficient site circulation and by designing taller buildings with smaller footprints or tuck-under parking,
Green Roofs	May be "extensive" with a 3-7 inch lightweight substrate and a few types of low-profile, low-maintenance plants, or may be "intensive" with a thicker substrate, more varied plantings, and a more garden-like appearance.
Disconnected Downspouts	Rather than connecting directly to storm drains, extended leaders direct roof runoff away from the building to nearby landscape detention, pop-up emitters, or infiltration devices.
Cisterns	Above ground storage vessels, sometimes with a manually operated valve, store runoff for post-storm discharge to landscaping.
Amending Soils	Soil amendments and tilling enhance or restore permeability and storage in the top layer of soils, reducing runoff.
Structural Soils	An engineered mix of angular aggregate and clayey loam provides structural support for sidewalks and paving while creating void spaces to support urban tree roots and promote infiltration.
Site Grading	Using gentler slopes and concave areas to reduce runoff and encourage infiltration; design landscaped areas to be self-retaining.
Pervious Pavements	Special mixes of concrete and asphalt. Require a base course of crushed aggregate and installation by experienced crews.
Unit Pavers	Traditional bricks, stone, or other pavers on sand or fine crushed aggregate.
B. Indirect Infiltration	
Flow-through Planter Box	Contained planter, usually above-ground, holds runoff in a surface reservoir and lets it infiltrate through a layer of soil. Infiltrated runoff collects in a gravel layer below, seeps into a perforated pipe underdrain, and is drained to a storm drain or discharge point.
Infiltration Planter	In-ground planter collects runoff from roofs and paved surfaces and allows it to percolate through permeable soil. May require an underdrain if the underlying native soils are poorly drained.
Bioretention	Briefly ponds stormwater on the surface of a shallow depression and allows it to percolate through permeable soil. May require underdrains if underlying native soils are poorly drained.
Vegetated or Grassy Swale	Works like bioretention, but also transmits high flows along its length.
C. Direct Infiltration	
Infiltration Basin	An excavation exposes relatively permeable soils and impounds water for rapid infiltration.
Dry Well	Small, deep hole filled with open graded aggregate. Sides may be lined with filter fabric or may be structural (i.e., an open bottom box sunk below grade). Typically receives roof runoff.
Infiltration Trench	Trench, with no outlet, filled with rock or open graded aggregate.

example designs, are in Attachment C-1. Some fact sheets include minimum design requirements for using these facilities to meet the C.3 permit provisions. Factors Affecting Feasibility of Infiltration

A variety of factors may limit or prevent use of a particular stormwater infiltration method on a particular site. Some factors, such as clayey soils or high groundwater, make direct infiltration infeasible. However, it may be possible to use indirect infiltration methods on these sites if water percolating through surface soils is underdrained and prevented from reaching groundwater.

Table C-2 summarizes the factors that may limit the feasibility of a particular stormwater infiltration method on a particular site.

The factors include:

Terrain. Stormwater infiltration is most feasible on flatter sites. Surface flows applied to slopes may run off rather than soaking into the ground. On hillsides, infiltrated runoff will tend to surface a short distance downstream and may also cause geotechnical instability (see below).

Soil types. The United States Department of Agriculture Natural Resources Conservation Service (NRCS, formerly the Soil Conservation Service) classifies soil types into four hydrologic soil groups.

- Group A soils are typically sands, loamy sands or sandy loams. Group A soils have low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.
- Group B soils are typically silt loams or loams. They have a moderate infiltration rate when thoroughly wetted and consist chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.
- Group C soils are typically sandy clay loams. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.
- Group D soils are typically clay loams, silty clay loams, sandy clays, silty clays or clays. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

Surface soils in much of Contra Costa County are in Group C or Group D. A few areas in the eastern part of the County have Group A soils. There are a few pockets of Group A and B soils scattered throughout the County. Infiltration through Group C and Group D soils is generally infeasible. However, surface infiltration may be possible if surface soils are amended or imported and are sufficiently well-drained (by underdrains if necessary).

TABLE C-2. Typical factors that may restrict feasibility of stormwater infiltration on a particular site.
Blank cells mean: This factor is typically not a barrier to implementing this infiltration method.

Infiltration Method	*Terrain (Surface Slope)*	*Geotechnical Considerations*	*Soils*	*Potential Groundwater Pollution*
Site Design Practices				
Site Layout Practices				
Green Roofs				
Disconnected Downspouts	Not suitable on slopes >4% unless terraced	Extend leaders away from and downslope of structures		
Cisterns				
Amending Soils				
Structural Soils	Not suitable on slopes >4% unless terraced	Set back from structures		
Site Grading				
Pervious Pavements			Use a thicker base of drainage rock and positive drainage over poorly draining soils	
Unit Pavers				
Indirect Infiltration				
Flow-through Planter Box				
Infiltration Planter	Not suitable for slopes; planter must be level	Protect adjacent pavement and structures from infiltrating moisture. Generally not suitable on slopes that exceed 15%.	Provide underdrains in poorly draining (Groups "C" and "D") soils	
Bioretention	Not suitable for slopes; use underdrained planter boxes instead			
Vegetated or Grassy Swales	Not suitable for slopes >6%			
Direct Infiltration				
Infiltration Basin	Generally not suitable where slopes exceed 15%. Set back from structures.		May not be feasible in "C" soils. Not suitable in "D" soils.	Not allowed in industrial areas and high-traffic streets. Minimum depth to groundwater required. Set back from wells. See Table C-3.
Dry Well				
Infiltration Trench				

Geotechnical considerations. Increased water pressure in soil pores reduces soil strength, making foundations more susceptible to settlement and slopes more susceptible to failure. In general, infiltration areas or devices must be set back from building foundations or steep slopes. Specific requirements for each site should be determined by a qualified geotechnical engineer.

Depth to groundwater. To protect groundwater quality, the Water Boards require devices designed for direct infiltration have a 10-foot minimum separation between the bottom of the device and the high seasonal groundwater level.

Potential groundwater pollution. The Water Boards prohibit direct infiltration of runoff from some land uses, including industrial or light industrial areas; areas subject to high vehicular traffic (25,000 or greater average daily traffic on main roadway or 15,000 or more average daily traffic on any intersecting roadway); automotive repair shops; car washes; fleet storage areas (bus, truck, etc.), nurseries, and other areas where there is a high potential for pollutants in runoff. See Table C-3.

Existing groundwater pollution. Infiltration should be avoided where it could contribute to the movement or dispersion of previously polluted groundwater. This includes sites listed by the Water Boards' Leaking Underground Storage Tanks (LUST) and Spills, Leaks, Investigations, and Complaints (SLIC) programs.

Vector control and maintenance. Infiltration systems must be designed and maintained to ensure long-term performance and to avoid harboring mosquitoes and other vectors. Detailed design and maintenance requirements for specific systems are on the accompanying information sheets. Infiltration systems should not be used on sites where the design criteria cannot be achieved or where maintenance over the life of the project cannot be assured.

Design and Maintenance for Vector Control

The general design principles to be applied are:

- Design structures so that they do not hold standing water for more than 72 hours.[1] Special attention to groundwater depth is essential to avoid prolonged ponding.

- Locate and design facilities to avoid entry of fine sediment, which may cause systems to clog and fail and may also result in standing water.

[1] CCMVCD personnel note that the following minimum mosquito production periods are typical to Contra Costa County: December-February, two weeks; April-May, 10 days; June-October, 3-5 days (3-4 days in areas that are exceptionally warm in summer). Devices that hold standing water fewer than five days will rarely cause problems.

TABLE C-3. Guidelines on the Use of Direct Infiltration Devices

Direct Infiltration device: "Any structure that is designed to infiltrate storm water into the subsurface, and as designed, bypasses the natural groundwater protection afforded by surface or near-surface soil."*

Examples

Dry well: Structure placed in an excavation or boring, or excavation filled with open-graded rock, that is designed to collect stormwater and infiltrate into the subsurface soil.

Infiltration basin: Shallow impoundment that is designed to infiltrate stormwater into subsurface soil.

Infiltration trench: Long narrow trench filled with permeable material (e.g. gravel), which may contain perforated pipe, designed to store runoff and infiltrate through the bottom and sides into the subsurface soil. Includes French drain.

Criteria for Direct Infiltration

Groundwater separation (default)	> 10 feet from bottom of device to seasonal high groundwater.
Land use activities in drainage area	No high-risk land uses, including industrial, automotive repair shops, car washes, fleet storage areas, nurseries, landfills, and agricultural uses. No hazardous materials, chemical storage, or waste disposal.
Level of vehicular traffic	<25,000 ADT main roads; <15,000 ADT minor roads
Horizontal setbacks:	
Drinking water wells (active or not properly decommissioned)	> 100 feet
Septic Systems	> 100 feet
Underground storage tanks with hazardous materials	> 500 feet
Hillside stability	Recommend geotechnical analysis when slopes are > 7%

*Santa Clara Valley Urban Runoff Pollution Prevention Program, *C.3 Stormwater Handbook* (2004), Attachment III-3.

- Select locations that will allow flow by gravity to, through, and away from the facility. Pumps are not recommended because they are subject to failure and often require sumps.

- Design distribution piping and containment basins with adequate slopes to drain fully and prevent standing water. Take into consideration the buildup of sediment between maintenance periods. Compaction during grading may be needed to avoid slumping and settling, which can create depressions that will hold water. However, avoid compaction of infiltration areas.

- Avoid the use of loose riprap or concrete depressions that may hold standing water.

- Avoid barriers, diversions, or flow spreaders that may retain standing water.
- Completely seal structures that retain water permanently or longer than 72 hours to prevent entry of adult mosquitoes. Adult female mosquitoes can penetrate openings as small as $^{1}/_{16}$ inch to gain access to water for egg laying. Screening can exclude mosquitoes but is subject to damage and is not a method of choice.
- Design devices with the appropriate pumping, piping, valves, or other necessary equipment to allow for easy dewatering if necessary.
- Design devices for easy access for inspection and without the need for confined-space entry.

Maintenance requirements include the following:

- Observe soil at the bottom of the swale or filter for uniform percolation throughout. If portions of the swale or filter do not drain within 48 hours after the end of a storm, the soil should be tilled, replanted, or replaced. Remove any debris or accumulations of sediment.
- Confirm that check dams and flow spreaders are in place and level and that channelization within the swale or filter is effectively prevented.

Procedure for Selecting Infiltration Systems

The following procedure is recommended:

1. Review the “Rules of Thumb” below.
2. Obtain a Screening Report for Your Site
3. Complete Your Site Investigation
4. Document Your Design

► RULES OF THUMB

In practice, the best stormwater infiltration method for a particular site is most likely to be determined by the following considerations (or rules of thumb):

- Site design practices—including green roofs, disconnected downspouts, cisterns, amended soils, structural soils, self-retaining pervious areas, and pervious pavements—are applicable to most sites and can be used to reduce the required number or size of direct and indirect infiltration systems.

- Infiltration to groundwater is generally not feasible on steep or unstable slopes. Site layout practices (limiting impervious area) may be appropriate if approved by a geotechnical engineer. Runoff may be detained or treated in green roofs and cisterns or in flow-through planter boxes or similar systems which have been isolated from underlying soils by an impermeable liner.

- On sites with clay soils (Hydrologic Soil Group "C" or "D"), swales or bioretention areas may be used only if drainage is sufficient or underdrains are provided. Some indirect infiltration to groundwater will occur and will enhance the effectiveness of these systems. Site design practices such as disconnected downspouts and pervious paving may be used if soils are amended and positively drained.

- On sites with well-drained soils (Hydrologic Soil Group "A" or "B"), direct infiltration by dry wells or infiltration trenches may be the most low-cost and space-efficient method for managing stormwater, subject to restrictions on land uses, depth to groundwater, and proximity to wells. (See Table C-3.) The potential for clogging with fine sediments should also be considered. If any of these limitations are present, swales or bioretention areas may be used to treat stormwater before it percolates to the permeable native soils underneath.

► SCREENING REPORT

The Contra Costa Clean Water Program has developed a simple way to obtain relevant available data for any particular location within the County. In response to input of an Assessor's Parcel Number (APN) for a site or coordinates for a particular location, the Program's query tool will produce a brief text report summarizing:

- Hydrologic soil groups.
- Land-use categories.
- Heavily trafficked roadways.
- Slopes.
- Recorded geologic hazards.
- Known locations of potential soil and/or groundwater contamination.
- Presence of vulnerable groundwater areas or existing water supply wells.

The query tool presents information available for locations on or near the site. It is also possible to map applicable information at and near the site.

The resulting report and graphics should be used as a template and a starting point for investigation, by competent professionals, of existing conditions and stormwater management options specific to the site.

Contact the Clean Water Program for further information or to use of the query tool.

► COMPLETE YOUR SITE INVESTIGATION

Based on the "rules of thumb" and the report produced by the Program's query tool, consider the stormwater infiltration options that may be suitable to your site.

If you plan to use site design practices and indirect infiltration methods (swales and bioretention areas), proceed to preliminary sizing and design of these facilities.

If you plan to use direct infiltration, you will need to investigate further to confirm infiltration rates of soils at proposed locations of the infiltration devices. Infiltration testing methods are in Attachment C-2.

In addition, further investigation should be conducted of:

- Depth to groundwater, based on well logs, boring logs, or other available data.
- Vulnerable groundwater areas and water supply wells, based on a review of past uses of the site, visual evidence, and records.
- Potential soil or groundwater contamination, based on a review of past uses of the site, visual evidence, and records.

► DOCUMENT YOUR DESIGN

Chapter Five of the Program's *Stormwater C.3 Guidebook* includes instructions for sizing and preliminary design of stormwater management facilities. The Chapter Five procedure emphasizes the use of roof runoff controls to reduce runoff and the use of grading, paving, and landscaping techniques to create self-retaining areas. Runoff from impervious areas can be routed to Integrated Management Practices (IMPs), which include direct and indirect infiltration devices. The *Stormwater C.3 Guidebook* also includes minimum requirements and checklists for a Stormwater Control Plan to be submitted with applications for planning and zoning review.

The information sheets in Attachment C–1 will assist development of preliminary and final design for stormwater infiltration facilities.[1]

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[1] Fact sheets are provided for some, but not all, of the "Category A—Site Design Practices" discussed in the text and listed in Table C-1. See Chapter 3 of this *Stormwater C.3 Guidebook* and the References and Resources above for additional guidance on site design.

Category A: Site Design Practices

C–1–1	Green Roofs	1 pp.
C–1–2	Downspouts and Cisterns	2 pp.
C–1–3	Grading, Paving, and Landscaping	2 pp.

Category B: Indirect Infiltration Practices

C–1–4	Flow-through Planter	2 pp.
C–1–5	Infiltration Planter	2 pp.
C–1–6	Bioretention	3 pp.
C–1–7	Vegetated or Grassy (“Dry”) Swale	3 pp.

Category C: Direct Infiltration Practices

C–1–8	Infiltration Basin	3 pp.
C–1–9	Dry Well	3 pp.
C–1–10	Infiltration Trench	3 pp.

As described in *Guidebook* Chapters 5 and 6, locate and design your stormwater management facilities to ensure access for maintenance and to minimize the potential for harboring vectors.

References and Resources

- RWQCB Order R2-2003-0022, Provision C.3.i—Limitation on Use of Infiltration Treatment Measures—Infiltration and Groundwater Protection
- USEPA Fact Sheet, “When are Storm Water Discharges Regulated as Class V Wells?”
- *Start at the Source* (BASMAA, 1999).
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003) Fact Sheets
  - Bioretention
  - Extended Detention Basin
  - Infiltration Basin
  - Infiltration Trench
  - Retention/Irrigation
  - Vegetated Swale
- www.greenroofs.org
- “Structural Soil: An Innovative Medium Under Pavement that Improves Street Tree Vigor,” Cornell University Urban Horticulture Institute.

Green Roofs

Gap Headquarters, San Bruno (*William McDonough & Partners*)

Green roofs can be either *extensive*, with a 3"-7" lightweight substrate and a few types of low-profile, low-maintenance plants, or *intensive* with a thicker (8" to 48") substrate, more varied plantings, and a more garden-like appearance.

The extensive installation pictured above, at Gap Headquarters in San Bruno, has experienced relatively few problems after nearly a decade in use.

Design and Construction. Extensive green roof systems contain several layers of protective materials to convey water away from the roof deck. Starting from the bottom up, a waterproof membrane is installed, followed by a root barrier, a layer of insulation (optional), a drainage layer, a filter fabric for fine soils, the engineered growing medium or soil substrate, and the plant material.

Design and installation is typically by an established vendor.

Maintenance. Installations require inspection at least semiannually and may or may not require irrigation in the Bay Area semi-arid climate.

See www.greenroofs.com for information about and more examples of green roofs.

Agilent Headquarters, Santa Clara (*Agilent*)

Best Uses

- New buildings with innovative architecture
- Urban centers

Advantages

- Minimize roof runoff
- Reduce “heat island” effect
- Absorb sound
- Provide bird habitat
- Structural requirements similar to other roofing options (for extensive green roofs).
- Maintenance costs similar to other roofing options

Limitations

- Sloped roofs require steps or cross-battens
- Non-traditional design

Contra Costa Clean Water Program

Integrated Management Practices Fact Sheets

Downspouts and Cisterns

Construction Innovation Forum

Better Homes & Gardens

Drainage from roofs can be directed to pervious areas and allowed to infiltrate into the soil. No further treatment or detention is required if the ratio of impervious to pervious area does not exceed 2:1 for treatment only, 1:1 for flow control plus treatment. "Self-retaining" pervious areas must be graded and designed to retain at least 1" rainfall over the entire area, as described in the fact sheet for grading, paving, and landscaping.

Splash blocks, swales, or pipes direct downspout discharge away from foundations to lawns or planting beds. Shallow depressions, or "rain gardens," may collect and detain runoff.

Cisterns or rain barrels can capture and detain a portion of the runoff and allow it to seep away slowly. These devices may have a valve to control when and how fast they empty. Cisterns can also expand the effective capacity of dry wells, infiltration trenches, and other infiltration practices.

Design and Construction. Cisterns or rain barrels can be fashioned from a variety of materials. Cisterns capable of retaining water for more than 72 hours must be sealed against entry by mosquitoes, which can enter openings as small as $^{1}/_{16}$".

Maintenance. Maintenance consists of inspecting cisterns and piping and removing any accumulated sediment.

Best Uses

- Landscaped areas near buildings

Advantages

- Low-cost
- Versatile
- Conserves water
- Low maintenance

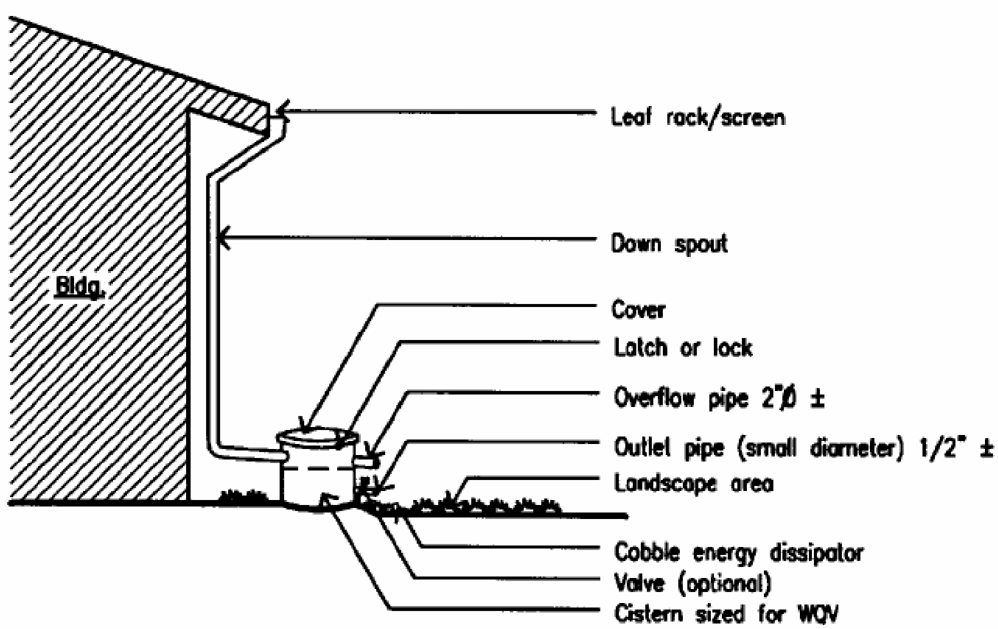
Limitations

- Soils receiving runoff must be adequately drained.
- Foundations should be protected from excessive moisture in expansive clay soils.
- Impervious-to-pervious ratio should not exceed 2:1 for treatment only, 1:1 for flow control and treatment.
- Bay Area seasonal rainfall patterns make water storage somewhat less attractive.

Contra Costa Clean Water Program

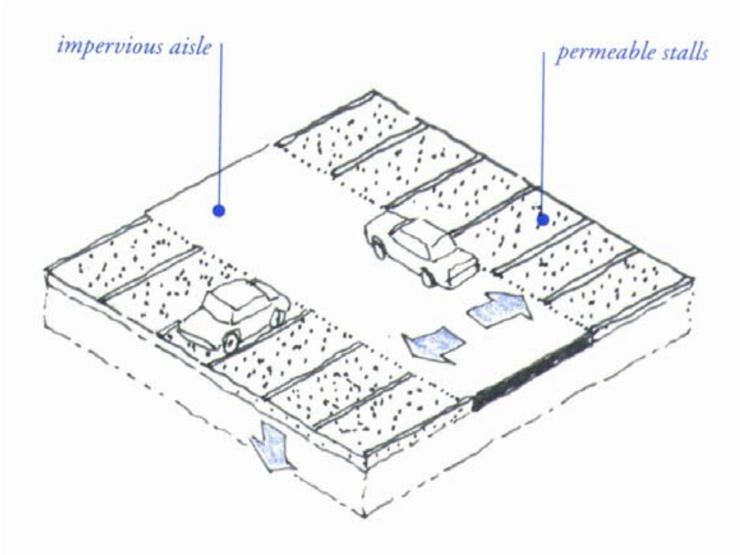
Design Checklist for Downspouts and Cisterns

- ❐ Discharge is directed away from foundations.
- ❐ Receiving landscaped area is at least ½ tributary impervious (roof) area (1:1 ratio applies if flow-control is required).
- ❐ Receiving landscaped area is designed to retain runoff (see Grading, Paving, and Landscaping Fact Sheet).
- ❐ Slopes do not exceed 4% (unless terraced).
- ❐ Cistern valve or orifice designed to allow slow drainage.
- ❐ Cistern designed to drain completely within 72 hours or are tightly sealed against mosquito entry.
- ❐ Cistern overflow is directed to avoid damage.
- ❐ Cistern is designed to protect against access by small children (secure or less than 4" diameter top opening).



Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

Grading, Paving, and Landscaping



Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

The need for stormwater treatment can be minimized by designing pervious areas to be self-treating (runoff drains off-site without flowing on to impervious areas). Alternatively, pervious areas can also be self-retaining if they are designed to retain the first 1" of rainfall before any runoff enters storm drains.

Runoff from roofs or impervious paving can be allowed to drain on to self-retaining pervious areas without any additional requirement for stormwater treatment. Up to a 2:1 ratio of impervious area to pervious area is acceptable for treatment only; a 1:1 ratio is allowed for flow control plus treatment.

In paved areas, permeable pavements may substitute for traditional asphalt or concrete. Where native soils are clayey, a thick gravel base course provides additional storage under permeable pavements.

Design and Construction. Grade self-retaining landscaped areas to be concave. If area drains are necessary, set the inlet elevation above the low point or drainage line. Select pervious pavements to serve site aesthetics and uses. Pervious concrete is most suitable to low-traffic areas. Turf block pavers may be appropriate for overflow parking areas. Unit pavers such as brick, and crushed aggregate, are used in plazas and pedestrian walkways.

Best Uses

- Parking lots
- Common areas
- Lawns and landscape buffers

Advantages

- Reduce or eliminate need for stormwater treatment
- Does not require annual verification of maintenance
- Reduce drainage system cost and potential for flooding
- Can be an attractive landscape element

Limitations

- Potential for prolonged ponding if soils are poorly drained
- New varieties of pervious asphalt and concrete have not yet been widely accepted
- Typically higher costs for pervious pavements

Contra Costa Clean Water Program

Site Design Fact Sheet

Maintenance. Permeable asphalt and concrete may require periodic pressure washing or vacuuming to dislodge fines. Unit pavers may require seasonal weed suppression.

Design Checklist for Landscaped Self-Retaining Areas

❐ Entire self-retaining area is graded concave (i.e., will retain 1" rainfall over entire surface). Drain inlets, if any, are set above low point or flow line.

❐ Receiving landscaped area is at least ½ tributary impervious area (treatment only); equal to tributary impervious area (treatment plus flow-control).

❐ Lawn or other landscaped areas are graded with at least 6" curb reveal below adjacent pavement (to allow for turf growth without blocking sheet flow into landscaped area).

❐ Soils are suitable or will be adequately amended with organic matter to increase moisture-holding capacity.

Design Checklist for Permeable Pavements

❐ No erodable areas drain on to pavement.

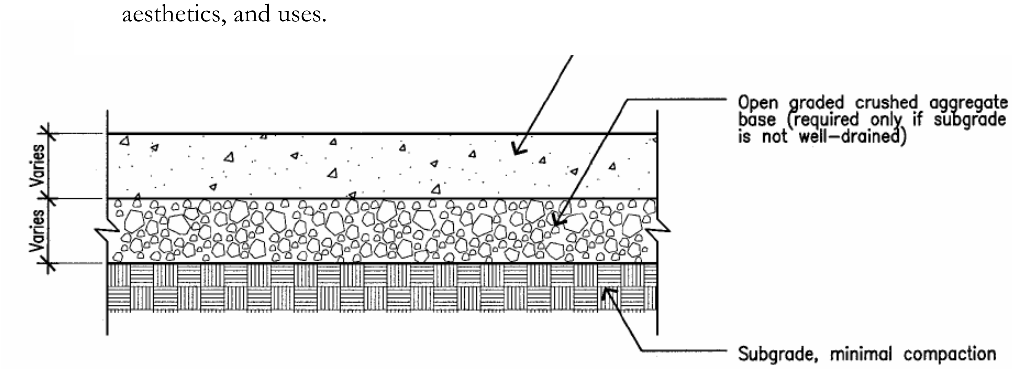
❐ Reservoir base course is of open-graded crushed stone. Base is adequate to retain rainfall and to support loads.

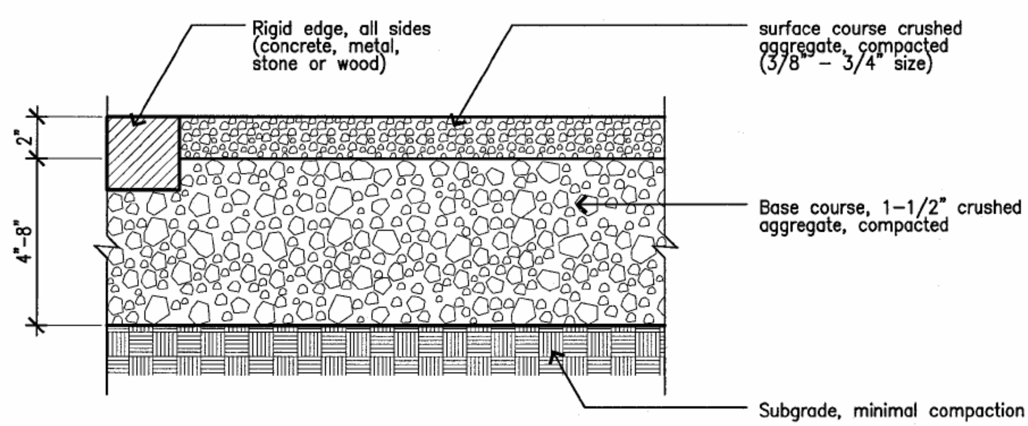
❐ Subgrade is uniform and slopes are not so steep that subgrade is prone to erosion.

❐ Rigid edge is provided to retain granular pavements and unit pavers.

❐ Permeable pavements will be installed by experienced professionals according to vendor's recommendations.

❐ Selection and location of pavements incorporates Americans with Disabilities Act requirements, site aesthetics, and uses.





Bay Area Stormwater Management Agencies Association, *Start at the Source* (1999)

Flow-through Planter

City of Portland *2004 Stormwater Manual*

Flow-through planters are designed to treat and detain runoff without allowing seepage into the underlying soil. They can be used next to buildings and other locations where soil moisture is a potential concern.

Flow-through planters typically receive runoff via downspouts leading from the roofs of adjacent buildings. However, flow-through planters can also be set level with the ground and receive sheet flow. (See the In-Ground Planter fact sheet.)

Pollutants are removed as the runoff passes through the soil layer and is collected in an underlying layer of gravel or drain rock. A perforated pipe underdrain must be piped to a storm drain or other discharge point. An overflow inlet conveys flows which exceed the capacity of the planter.

Design and Construction. Flow-through planters for stormwater treatment only must have a sizing factor (surface area of swale/surface area of tributary impervious area) of at least 0.04. Minimum sizing factors for treatment-plus-flow-control are incorporated into the Program's IMP sizing tool. Plantings should be selected for viability in a well-drained soil. Irrigation is required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system; inspect periodically and after storms to ensure structural integrity and that planter has not clogged.

Best Uses

- Retention and treatment of roof runoff
- Next to buildings
- Dense urban areas
- Where infiltration is not desired

Advantages

- Can be used next to structures
- Space-efficient
- Versatile
- Can be any shape
- Low maintenance

Limitations

- Requires underdrain
- Requires sufficient head between inlet and underdrain
- Requires careful selection of plant palette
- Must be installed level
- Typically requires irrigation

CONTRA COSTA CLEAN WATER PROGRAM

Integrated Management Practice Fact Sheets

Design Checklist for Flow-through Planter

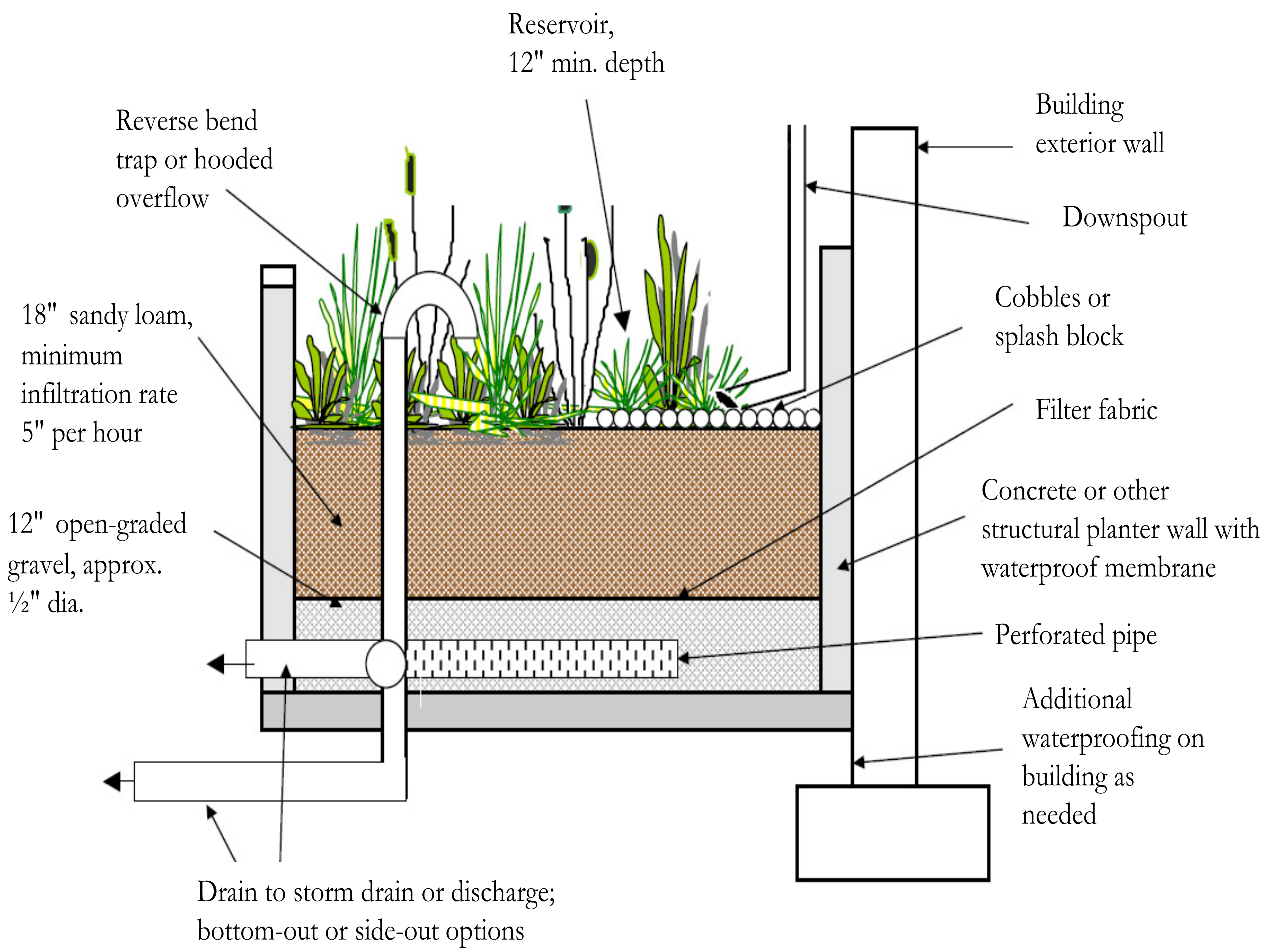
- ❐ Planter is installed level.
- ❐ Overflow adequate to meet municipal drainage requirements
- ❐ Minimum 12" deep reservoir at top of planter
- ❐ 18" deep "sandy loam" soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil, free of stones, stumps, roots, or similar objects, and also free of noxious weeds.
- ❐ Pea gravel or crushed rock layer beneath soil layer (see below for gravel layer depth requirements).
- ❐ Perforated pipe underdrain with cleanouts and connection to storm drain or discharge point.
- ❐ Adequate head from underdrain to storm drain or discharge point.
- ❐ Waterproofing as required to protect groundwater or building foundations.
- ❐ Splash blocks or cobbles at downspouts and inlet pipes
- ❐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❐ Irrigation system with connection to water supply.

Treatment Only design

- ❐ Minimum gravel layer depth 12".
- ❐ Ratio (surface area of planter)/(tributary impervious area) is at least 0.04.

Flow Control and Treatment design

- ❐ Minimum sizing factor depends on geographic location and native soil type; use sizing tool.
- ❐ Minimum gravel layer depth 18" (porosity 0.4).
- ❐ Perforated pipe underdrain with orifice or other control to limit flow rate to the maximum specified by the sizing tool.


Reservoir,
12" min. depth
Reverse bend
trap or hooded
overflow
Building
exterior wall
Downspout
18" sandy loam,
minimum
infiltration rate
5" per hour
Cobbles or
splash block
Filter fabric
12" open-graded
gravel, approx.
½" dia.
Concrete or other
structural planter wall with
waterproof membrane
Perforated pipe
Additional
waterproofing on
building as
needed
Drain to storm drain or discharge;
bottom-out or side-out options

In-Ground (Infiltration) Planter

City of Portland *2004 Stormwater Manual*

In-ground planters may receive runoff by piped inlet (see illustration) or by sheet flow across the adjoining pavement. An overflow inlet conveys flows which exceed the capacity of the planter. Pollutants are removed as runoff passes through a layer of imported engineered soil is collected in an underlying layer of gravel or drain rock.

Treated runoff may be allowed to infiltrate into the underlying native soil. A perforated pipe underdrain must be incorporated into the design when native soils are clayey (hydrologic soil groups "C" and "D") or when infiltration is not desired. The underdrain must be piped to a storm drain or other discharge point.

Design and Construction. In-ground planters in Contra Costa for stormwater treatment only must have a sizing factor (surface area of swale/surface area of tributary impervious area) of at least 0.04. Minimum sizing factors for treatment-plus-flow-control planters are incorporated into the Program's IMP sizing tool.

In-ground planters can be designed with curbs and curb-cut inlets (min. 12" width), which may be poured monolithically with the planter walls.

Maintenance. Maintain vegetation and irrigation system; inspect periodically to ensure structural integrity and that the planter has not clogged.

Best Uses

- Parking lot islands
- Plazas
- Along walkways

Advantages

- Space-efficient
- Versatile
- Can be any shape
- Low maintenance

Limitations

- Requires underdrain in clay soils
- Requires careful selection of plant palette
- Irrigation required to maintain plant viability.
- Must be installed level

Contra Costa Clean Water Program

Integrated Management Practice Fact Sheets

Design Checklist for In-Ground Planter

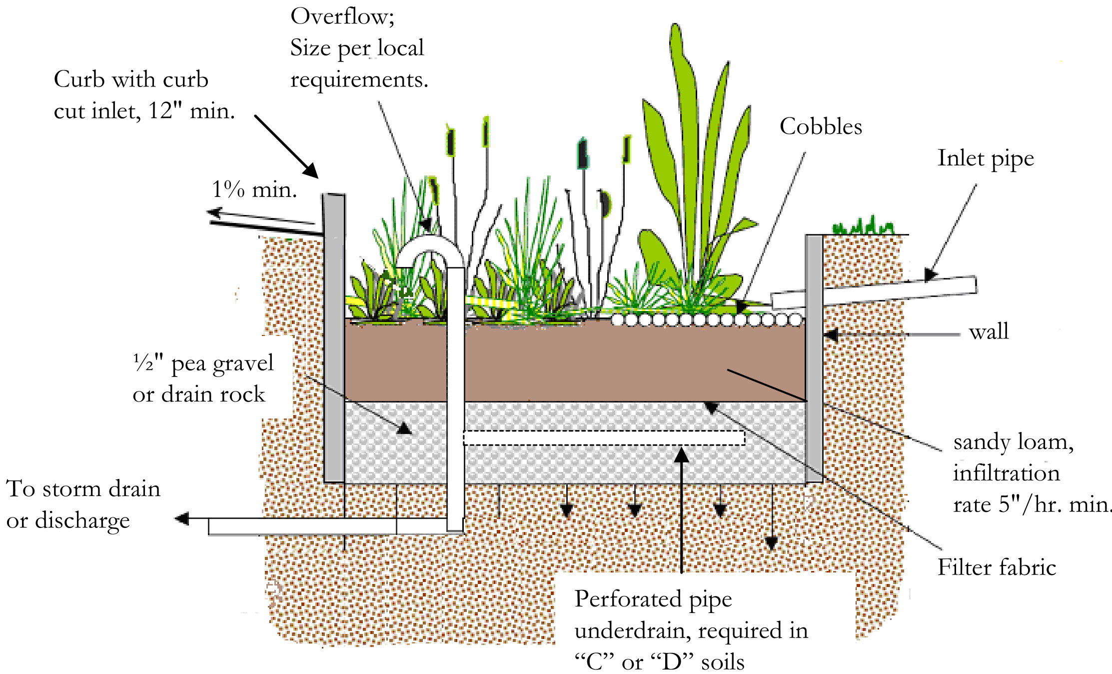
- ❒ Set back from structures 10' minimum or as required by structural or geotechnical engineer.
- ❒ Planter is installed level.
- ❒ Overflow adequate to meet municipal drainage requirements
- ❒ Minimum 12" deep reservoir at top of planter
- ❒ 18" deep “sandy loam” soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil, free of stones, stumps, roots, or similar objects, and also free of noxious weeds.
- ❒ Pea gravel or crushed rock layer beneath soil layer (see below for gravel layer depth requirements).
- ❒ 12" minimum width of curb cut with ½" drop across cut to avoid collection of debris.
- ❒ Splash blocks or cobbles at inlets and inlet pipes
- ❒ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❒ Native soils protected against compaction during construction.
- ❒ Irrigation system with connection to water supply.
- ❒ Perforated pipe underdrain (where required) with connection to storm drain or discharge point.
- ❒ If an underdrain is required, adequate head to reach storm drain or discharge point.

Treatment Only design

- ❒ Minimum gravel layer depth 12"
- ❒ Ratio (surface area of planter)/(tributary impervious area) is at least 0.04.

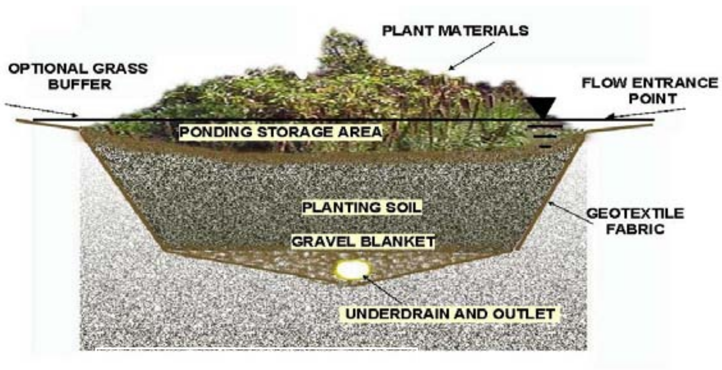
Flow Control and Treatment design

- ❒ Minimum gravel layer depth 18" (porosity 0.4).
- ❒ Minimum sizing factor depends on geographic location and native soil type; use sizing tool.
- ❒ Where required, perforated pipe underdrain with orifice or other control to limit flow rate to the maximum specified by the sizing tool.



Adapted from the City of Portland *2004 Stormwater Manual*

Bioretention Area



(Prince George's County 1993)

Bioretention areas remove stormwater pollutants through a combination of overland flow through vegetation, surface detention, and filtration through soil.

Treated runoff may be allowed to infiltrate into the underlying native soil. A perforated pipe underdrain must be provided for installations where native soils are clayey (hydrologic soil groups "C" and "D") or infiltration is not desired.

Design and Construction. Bioretention areas in Contra Costa must have a sizing factor (surface area of swale/surface area of tributary impervious area) of at least 0.04. Minimum sizing factors for treatment-plus-flow-control bioretention areas are incorporated into the Program's IMP sizing tool.

Beneath the soil, a layer of drain rock or pea gravel, up to 4' deep, stores treated runoff before it seeps into the native soil or underdrain. Plant species should be suitable to the well-drained soil and occasional inundation. If desired, larger trees are best planted at the periphery of the area.

Maintenance. Soils and plantings must be maintained, including routine pruning, replenishment of mulch, and weeding. The bioretention area should be inspected regularly and after storms. Erosion at inflow points must be repaired.

Best Uses

- Commercial, mixed-use and multi-family sites
- To treat runoff from areas up to 2 acres
- As a landscape design element

Advantages

- Low maintenance
- Reliable operation once established
- Versatile planting options

Limitations

- Vegetation requires frequent maintenance until established
- Irrigation typically required to maintain plant viability

CONTRA COSTA CLEAN WATER PROGRAM

Integrated Management Practice Fact Sheets

Design Checklist for Bioretention Areas

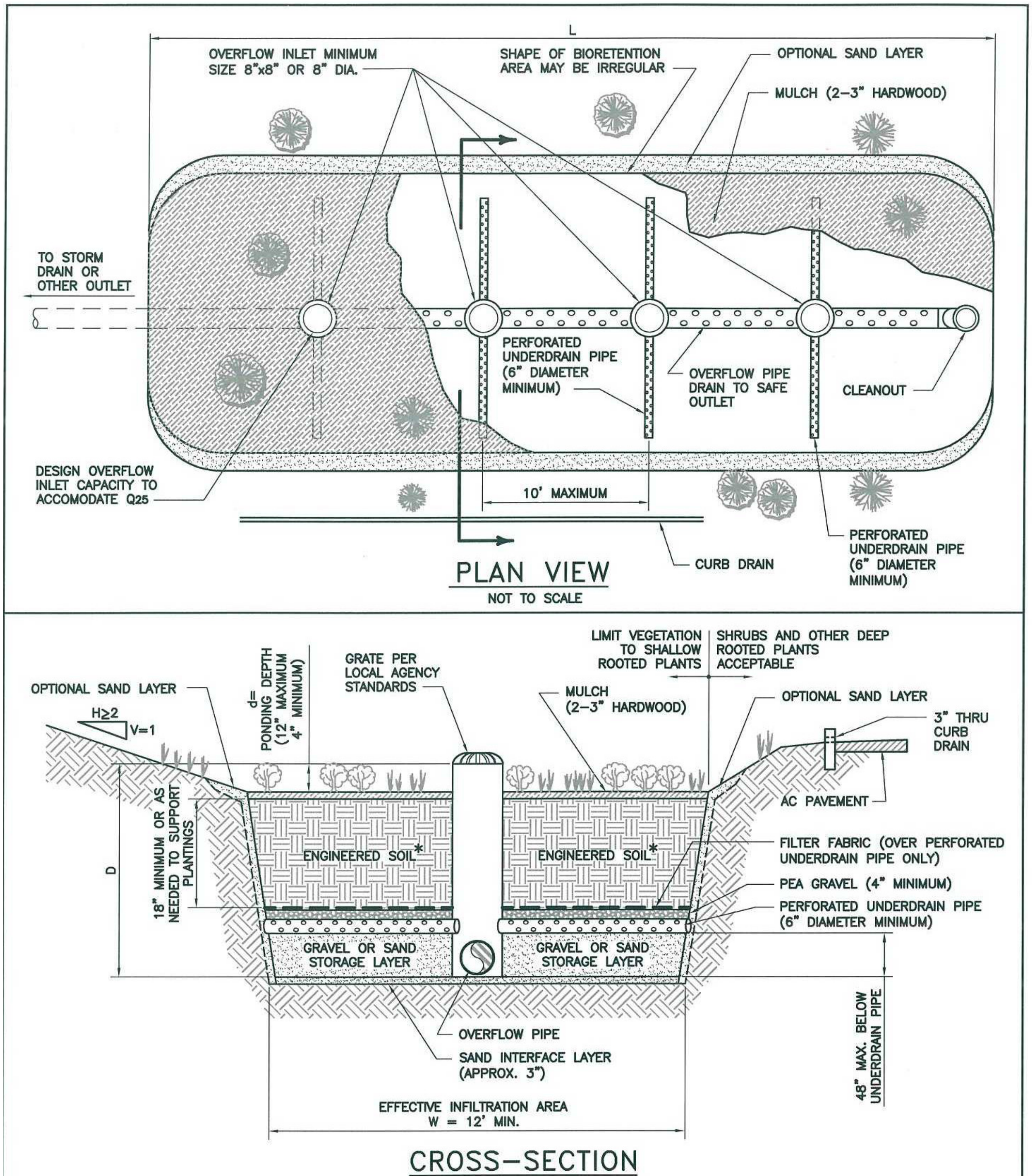
- ❐ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❐ Tributary impervious area does not exceed 2 acres.
- ❐ Tributary area does not contain a significant source of soil erosion.
- ❐ Surface is covered with 2"–3" mulch.
- ❐ Inlets are protected with rock or splash blocks.
- ❐ Overflow inlet can safely convey design flood flows to a downstream storm drain or discharge point.
- ❐ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❐ Irrigation system with connection to water supply.
- ❐ Trees and vegetation do not block inflow, create traffic or safety issues, or obstruct utilities.
- ❐ 18" deep "sandy loam" soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil, free of stones, stumps, roots, or similar objects, and also free of noxious weeds.
- ❐ Gravel layer not required in A and B soils (see below for gravel layer depth requirements).
- ❐ Perforated pipe underdrain (where required) with connection to storm drain or discharge point.
- ❐ If an underdrain is required, adequate head to reach storm drain or discharge point.

Treatment Only design

- ❐ Recommend side slopes no steeper than 4:1 (H:V)
- ❐ Design ponding depth is between 4" and 12"
- ❐ In C and D soils, up to 48" deep gravel layer underlying imported engineered soil.

Flow Control and Treatment design

- ❐ 4:1 (H:V) side slopes required; minimum 12' width.
- ❐ In C and D soils, 48" deep gravel layer beneath the entire extent of the imported engineered soil layer. Designs substituting equivalent storage volume (assume gravel layer porosity of 0.4) may be approved in place of the gravel layer.
- ❐ Where required, perforated pipe underdrain with orifice or other control to limit flow rate to the maximum specified by the sizing tool.
- ❐ Design ponding depth is 12".



NOTES:

1. ALL PERFORATED PIPE SHALL HAVE A MINIMUM OF THREE 3/4" DIAMETER HOLES, EQUALLY SPACED ALONG THE CIRCUMFERENCE OF THE PIPE AND NOT LESS THAN THREE HOLES PER LINED FOOT OF PIPE.
2. DETERMINE DIMENSIONS FROM L x W x D = INFILTRATION DESIGN VOLUME.

* SANDY LOAM/LOAMY SAND; FINES SHOULD BE LIMITED TO TWENTY PERCENT OR LESS PASSING THROUGH A #200 SIEVE.

SOURCE: MODIFIED FROM PAZ, 2004

Bioretention Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Vegetated or Grassy (“Dry”) Swale

In a “dry” swale, pollutants are removed as runoff seeps through a layer of imported engineered soil. Treated runoff then infiltrates into the underlying native soil. A perforated pipe underdrain is incorporated into the design where native soils are clayey (hydrologic soil groups “C” and “D”) or when infiltration is not desired. The underdrain must be piped to a storm drain or other discharge point.

Because the main mode of treatment is by filtration through the imported soil—not by settling and contact with vegetation—required detention times are minimal (~10 min.). Multiple inlets may be located along the length of the swale.

Design and Construction. Treatment-only swales in Contra Costa County must have a sizing factor (surface area of swale/surface area of tributary impervious area) of at least 0.04. Minimum sizing factors for treatment-plus-flow-control swales are incorporated into the Program’s IMP sizing tool.

Swales may be planted with turfgrass or with a palette of plants and trees. If grass is used, the design should include gentle slope transitions and access for mowing equipment. Plantings should be selected for viability in a well-drained soil with occasional inundation. Irrigation is typically required to maintain plant viability.

Maintenance. Maintain vegetation and irrigation system. Inspect periodically and after storms to ensure that inlets and outlets have not clogged and rivulets have not formed.

Best Uses

- Landscape buffers
- Parking lots
- Where drainage is used as a design element

Advantages

- Provides treatment for lower flows
- Conveys high flows
- Versatile planting options
- Low maintenance

Limitations

- Minimum width required.
- Requires underdrain in clay soils
- Requires careful selection of plant palette
- Typically requires irrigation

CONTRA COSTA CLEAN WATER PROGRAM

Integrated Management Practice Fact Sheet

Design Checklist for Vegetated or Grassy ("Dry") Swale

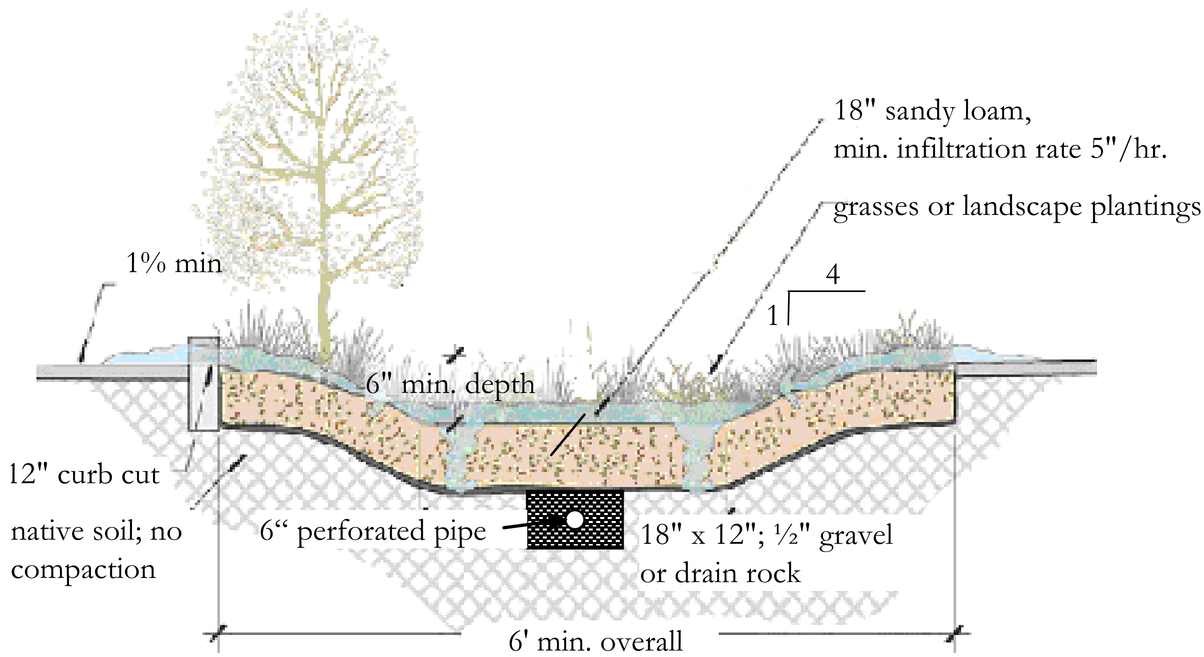
- ❒ Sides slopes no greater than 4:1. Smooth transitions, particularly if vegetation must be mowed.
- ❒ Longitudinal slope between 0.2% and 6%.
- ❒ Swale can convey the flood-protection design storm (see municipal requirements). Suggested Manning's *n* = 0.025–0.040 depending on height and density of vegetation.
- ❒ 18" deep "sandy loam" soil mix with no more than 5% clay content. Mix should be 50-60% sand, 20-30% compost, and 20-30% topsoil, free of stones, stumps, roots, or similar objects, and also free of noxious weeds.
- ❒ Set back from structures 10' minimum or as required by structural or geotechnical engineer.
- ❒ 12" minimum width of curb cut, with ½" drop across cut to avoid collection of debris.
- ❒ Splash blocks or cobbles at inlets and inlet pipes.
- ❒ Plants selected for viability and to minimize need for fertilizers and pesticides.
- ❒ Native soils protected against compaction during construction.
- ❒ Irrigation system with connection to water supply.
- ❒ Perforated pipe underdrain (where required) with connection to storm drain or discharge point. See below for underdrain bedding requirements.
- ❒ If an underdrain is required, adequate head to reach storm drain or discharge point.

Treatment Only design

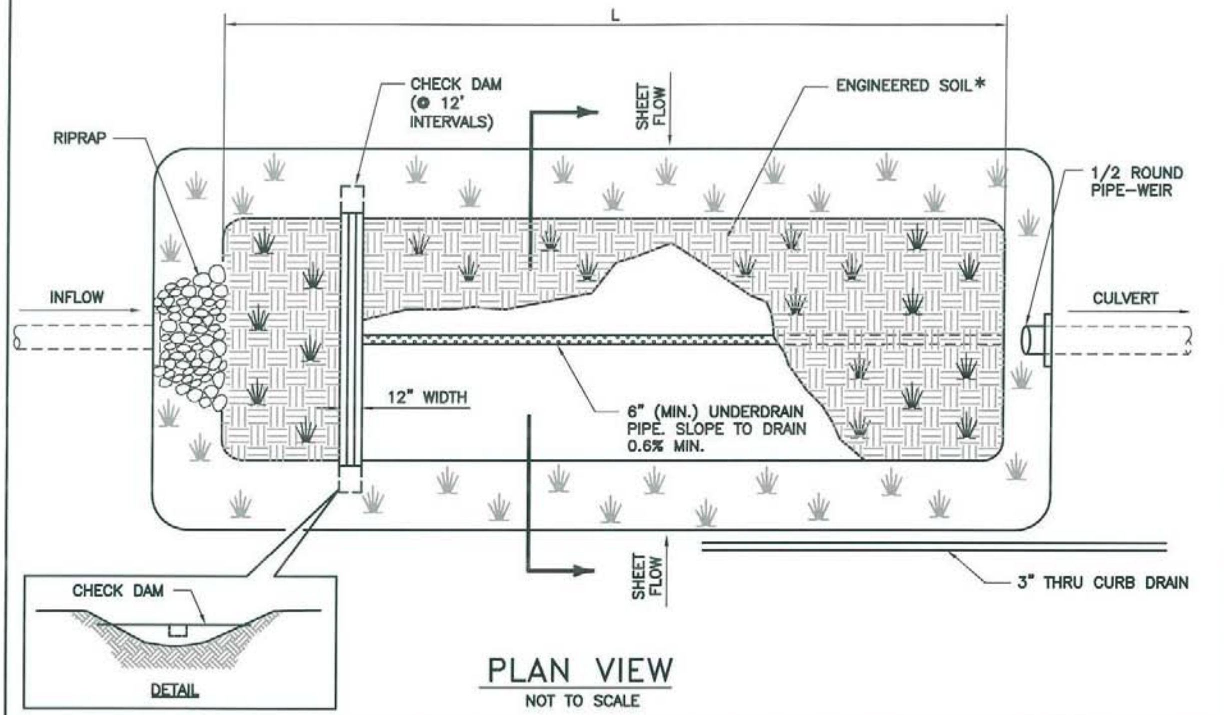
- ❒ Sizing factor (surface area of planter)/(tributary impervious area) is at least 0.04 (use sizing tool).
- ❒ Where required, perforated pipe underdrain in minimum 12" deep by 18" wide trench filled with pea gravel or crushed rock.
- ❒ On steeper slopes, check dams fashioned of rock, concrete, or similar material extend across the swale and keyed into the side slopes.
- ❒ 6" minimum swale depth (4 foot overall minimum width with 4:1 side slopes).

Flow Control and Treatment design

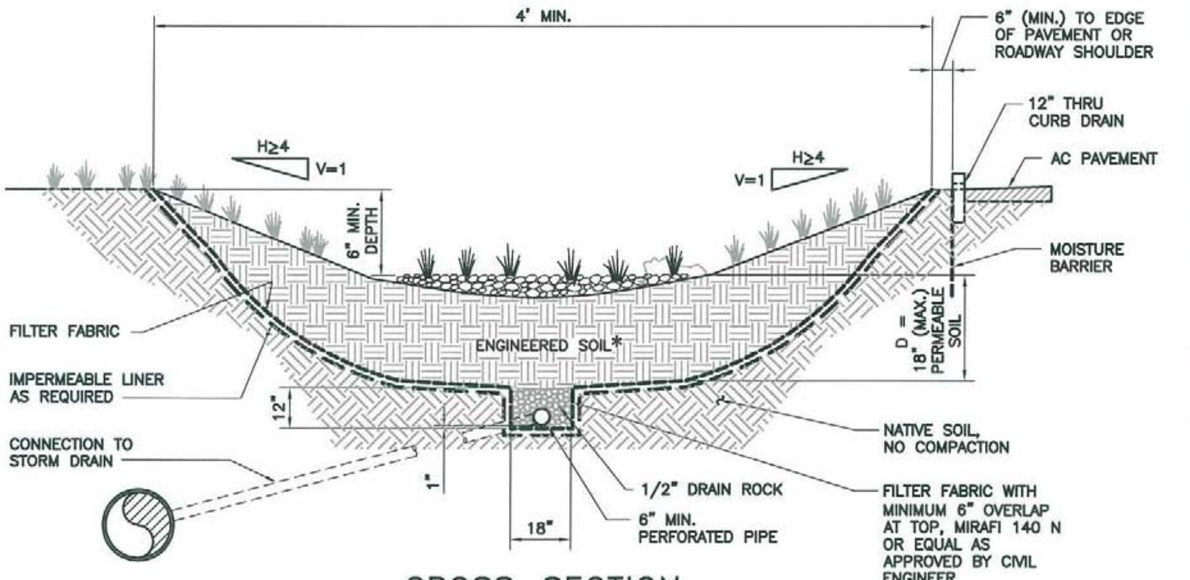
- ❒ Minimum sizing factor depends on geographic location and native soil type; use sizing tool.
- ❒ Check dams extend across the swale and are keyed into the side slopes, consist of sharp-crested vertical weirs with 90^{o} v-notch to ½ weir height, and are spaced minimum of every 12 feet. Weir height 2" less than swale depth.
- ❒ Where required, perforated pipe underdrain with orifice or other control to limit flow rate to the maximum specified by the sizing tool.
- ❒ 24" gravel layer extending the full width beneath the imported engineered soil layer. Designs substituting equivalent storage volume (assume gravel layer porosity of 0.4) may be approved in place of the 24" gravel layer.



Adapted from City of Portland *2004 Stormwater Manual*



PLAN VIEW
NOT TO SCALE



CROSS–SECTION
NOT TO SCALE

NOTES:

1. SWALE SHALL BE GRADED TO DRAIN TOWARD OUTLET AT A MINIMUM SLOPE 0.2%
2. ALL PERFORATED PIPE SHALL HAVE A MINIMUM OF THREE 3/4" DIA. HOLES EVENLY SPACED ALONG THE CIRCUMFERENCE OF THE PIPE AND NOT LESS THAN THREE HOLES PER LINEAL FOOT OF PIPE.
3. DETERMINE DIMENSIONS FROM (L x W x D) x SOIL VOIDS RATIO = INFILTRATION DESIGN VOLUME
4. PLANTINGS MAY INCLUDE TREES, MINIMUM INFILTRATION RATE 5"/HR

* SANDY LOAM/LOAMY SAND; FINES SHOULD BE LIMITED TO TWENTY PERCENT OR LESS PASSING THROUGH A #200 SIEVE.

SOURCE: MODIFIED FROM CENTER FOR WATERSHED PROTECTION, 2000

Vegetated Swale Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Infiltration Basin

Stormwater Infiltration Basin/Recreation Field—Stanford University

Infiltration basins are shallow impoundments, typically without no outlet, designed to temporarily store and infiltrate stormwater.

Suitable sites—flat, vegetated open spaces with highly permeable soils and sufficient depth to groundwater—are relatively rare in the Bay Area. The low cost of construction and low maintenance costs make infiltration basins an attractive option where they are feasible.

Design and Construction. The Contra Costa Clean Water Program's sizing tool will determine the required minimum basin area for a designated basin depth. For treatment-only, the resulting volume is equal to the minimum water-quality volume (California BMP method); for treatment-plus-flow-control, the area is the minimum necessary to ensure runoff does not exceed pre-project rates and durations.

The side slopes and bottom of the basin should be vegetated with a dense turf or other water-tolerant grass immediately after construction. The root systems of healthy vegetation will help keep soil pores open and help maintain the infiltration rate. An underdrain system is a valuable backup to ensure the basin can be drained even as soils begin to clog.

Maintenance. The basin should be inspected following storms to ensure the infiltration rate is adequate. Inlets and stilling basins should be inspected and accumulated sediment removed. Eroded or barren areas should be re-vegetated.

Best Uses

- Flat open spaces with highly permeable soils
- Large developments

Advantages

- Can be combined with lawns, ballfields, or other park amenities
- Can serve drainage areas up to 50 acres
- Low initial cost
- Low maintenance

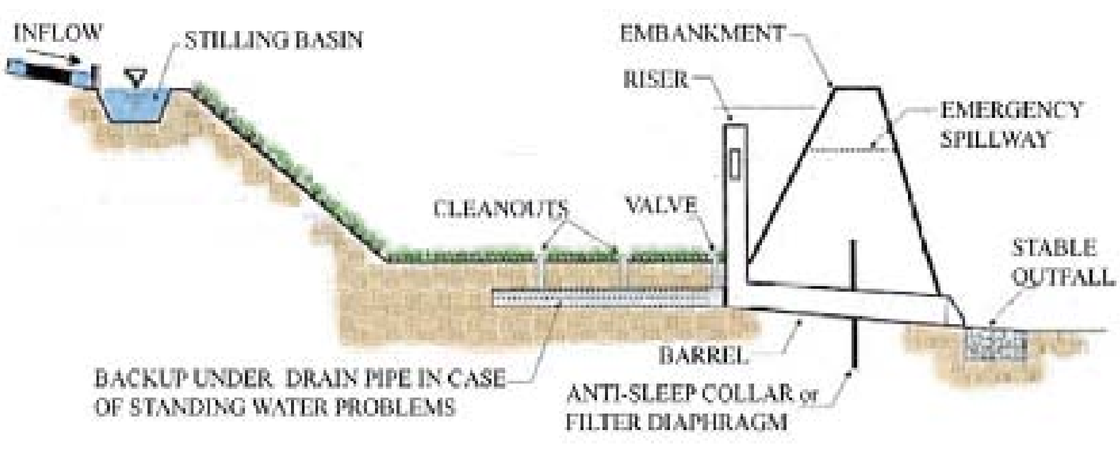
Limitations

- Not appropriate for clayey soils
- 10' minimum depth from bottom of basin to seasonal high groundwater
- Not suitable for industrial or "high risk" commercial areas or arterial streets
- Difficult to restore permeability once clogged.

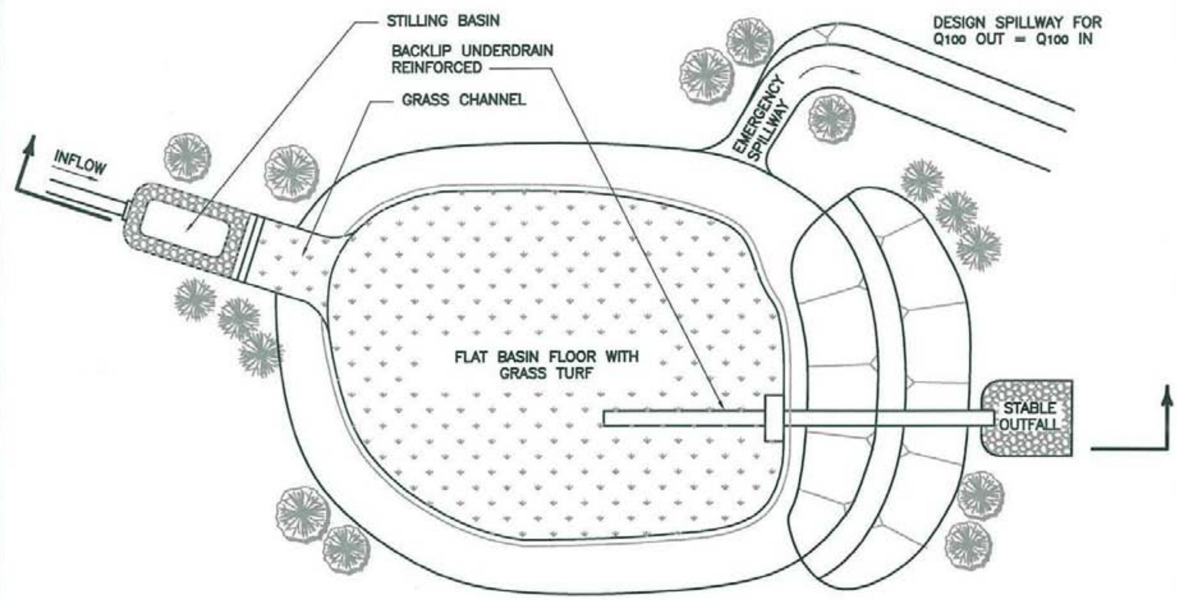
Integrated Management Practice Fact Sheets

Design Checklist for Infiltration Basin

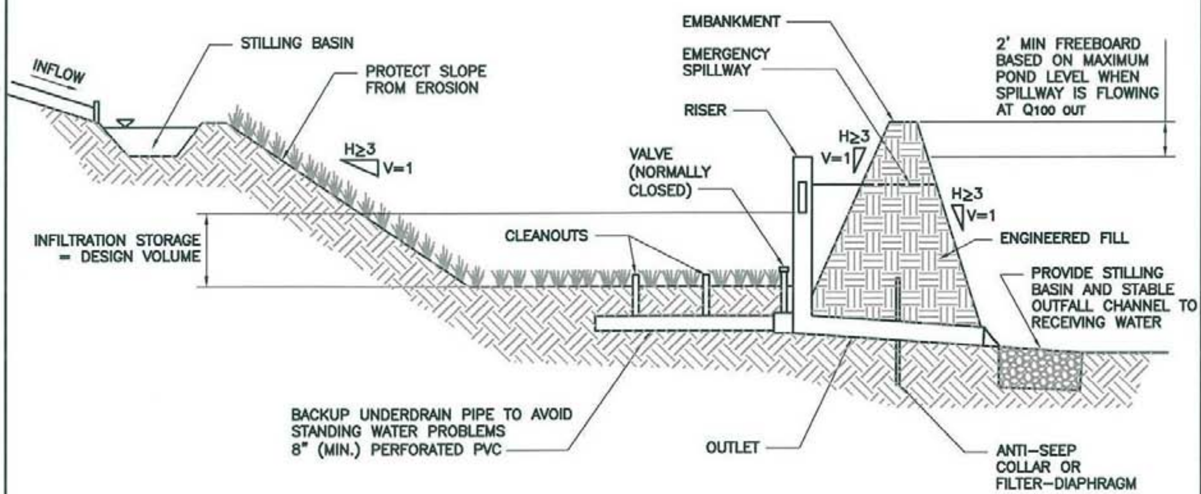
- ❒ Basin floor area is at least as large as that determined by the sizing tool for the design depth selected.
- ❒ Set back basin from structures 10' or as required by structural or geotechnical engineer.
- ❒ Depth from bottom of basin to seasonally high groundwater elevation is ≥10'.
  Depth to bedrock is ≥ 3'.
- ❒ Areas tributary to the infiltration basin do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❒ The infiltration basin is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❒ Areas tributary to the basin do not exceed 50 acres.
- ❒ Underlying soils are in hydrologic soil group A or B. Infiltration rate is sufficient to ensure a full basin will drain completely within 72 hours. Soil infiltration rate has been confirmed (Attachment C-2).
- ❒ All upstream drainage areas are stabilized prior to construction of the infiltration trench.
- ❒ The infiltration basin is equipped with an underdrain system, with cleanouts, for dewatering and in situations when the system becomes clogged.
- ❒ The infiltration basin is designed with an emergency spillway or overflow riser to prevent uncontrolled overflows.
- ❒ The side slopes and bottom are vegetated with a dense turf of water-tolerant grass immediately following construction.
- ❒ The floor of the basin is graded uniformly as possible for uniform ponding and infiltration. Basin side slopes are no greater than 3:1. Flatter side slopes are preferred for vegetative stabilization.
- ❒ One or more simple observation wells made of perforated PVC pipe, a footplate, and locking cover is installed in the infiltration basin.



PDEP 2004



PLAN VIEW
NOT TO SCALE



CROSS-SECTION
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NOTES:

1. CONFIRM WHETHER OR NOT THE BASIN IS WITHIN THE JURISDICTION OF THE STATE OF CALIFORNIA DIVISION OF SAFETY OF DAMS. (HEIGHT ≥ FEET OR CAPACITY ≥ 50 ACRE-FEET.
2. THE RISER AND OUTFALL SHALL BE SIZED TO PREVENT DISCHARGE OVER THE EMERGENCY SPILLWAY WITH Q100 FLOWING INTO THE BASIN. THE DESIGN ANALYSIS SHALL ASSUME THAT THE INFILTRATION STORAGE VOLUME IS NOT AVAILABLE FOR FLOOD ROUTING ALTERNATION.

SOURCE:
MODIFIED FROM WISCONSIN DNR, 2000

Infiltration Basin Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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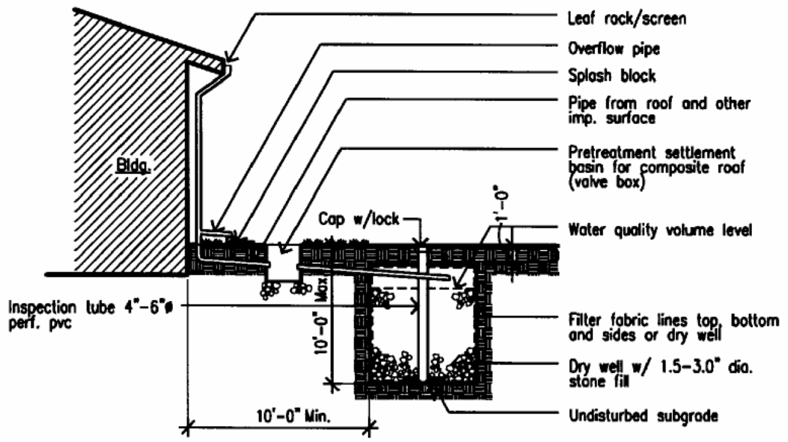
Dry Well



Bay Area Stormwater Management Agencies Association

Dry wells are typically a prefabricated structure, such as an unlined or open-bottomed vault or box, placed in an excavation or boring and filled with open-graded rock. Runoff is stored in the rock voids and allowed to infiltrate into the subsurface soil.

Design and Construction. The Contra Costa Clean Water Program's sizing tool will determine the required minimum area for a designated dry well depth. For treatment-only, the resulting volume is equal to the minimum water-quality volume (California BMP method); for treatment-plus-flow-control, the area is the minimum necessary to ensure runoff does not exceed pre-project rates and durations.

A simple observation well should be included and can be fashioned from a footplate, perforated PVC pipe, and a locking cover. An overflow should be provided to handle large runoff flows.

Maintenance. Dry wells should be inspected following storms to ensure water drains within 72 hours. Movement of water into the drain rock can sometimes be restored by removing and replacing the surface sand filter and filter fabric.

Best Uses

- Runoff from a single downspout

Advantages

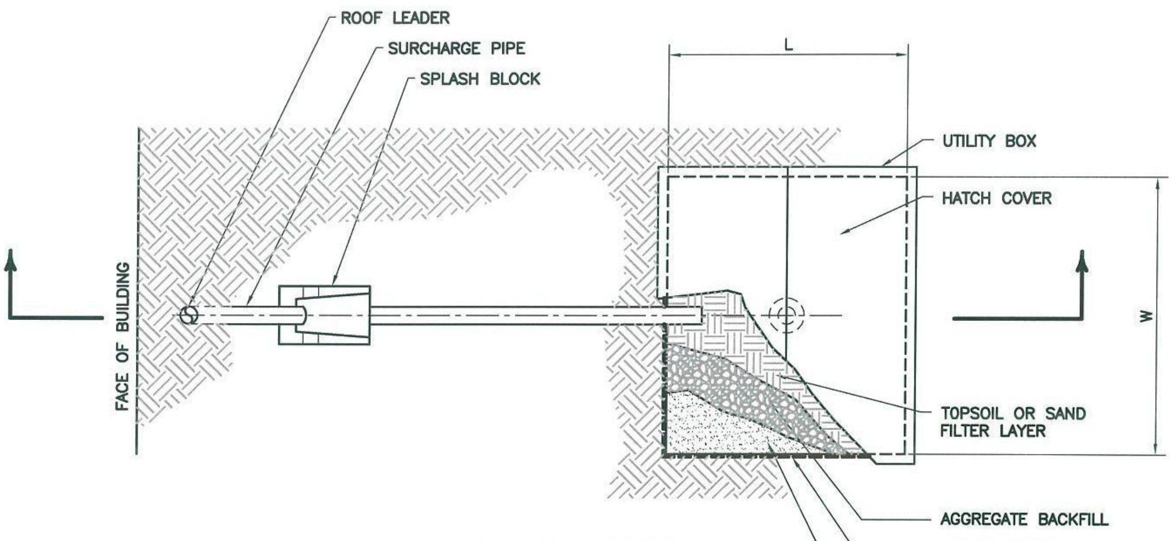
- May be installed in parking lots and paved areas
- Compact footprint
- Can be used in areas without storm drains

Limitations

- Generally not appropriate for clayey soils (Hydrologic Soil Groups C & D)
- 10' minimum depth from bottom of trench to seasonal high groundwater
- Not suitable for industrial or "high risk" commercial areas or arterial streets
- Clogging frequency depends on amount of fine sediment in influent

Design Checklist for Dry Well

- ❒ Dry well surface area is at least as large as that determined by the sizing tool for the design depth selected.
- ❒ A one-foot-deep storage reservoir is provided above the sand filter layer.
- ❒ Depth from bottom of dry well to seasonally high groundwater elevation is ≥10'.
  Depth to bedrock is ≥ 3'.
- ❒ Areas tributary to the infiltration trench do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❒ The dry well is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❒ Underlying soils are in hydrologic soil group A or B. Infiltration rate is sufficient to ensure a full basin will drain completely within 72 hours. Soil infiltration rate has been confirmed (Attachment C-2).
- ❒ The drainage area is less than one acre.
- ❒ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❒ An overflow is provided to handle large flows.
- ❒ An observation well is provided to allow for inspection and maintenance.
- ❒ Void spaces in trench fill accommodate the required water quality volume.
- ❒ Soil infiltration rate has been confirmed (Attachment C-3).
- ❒ Design includes an observation well.



PLAN VIEW

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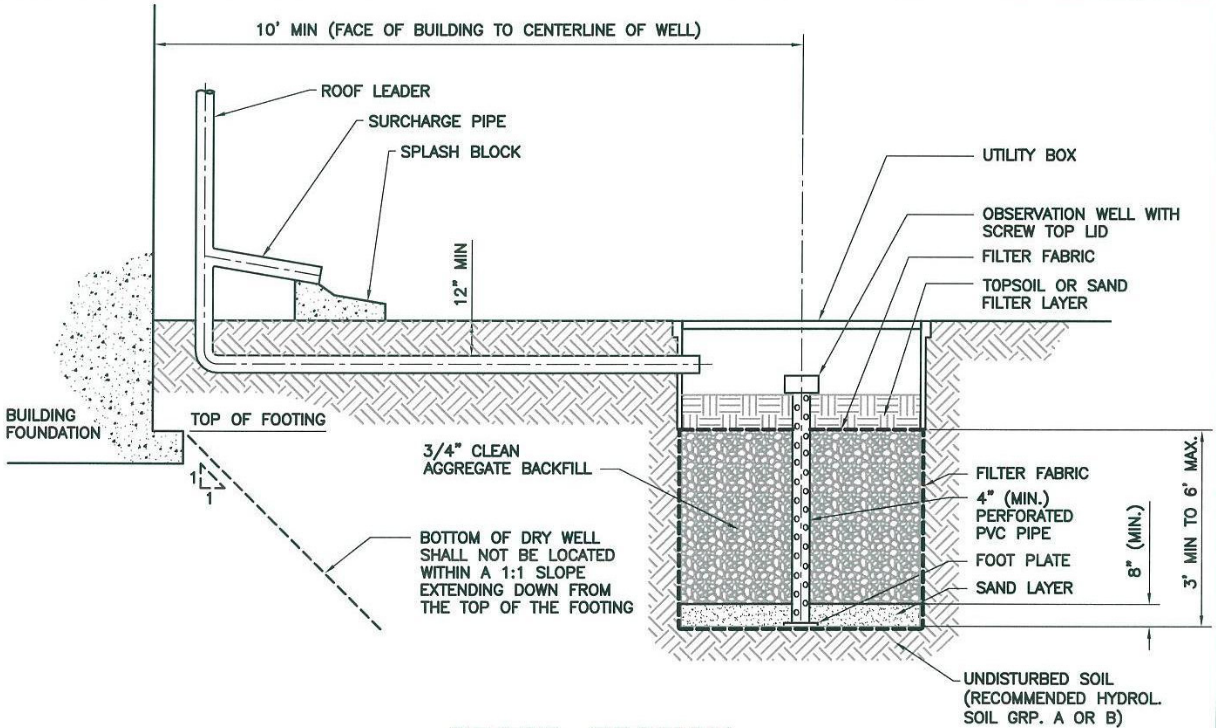

CROSS–SECTION

NOT TO SCALE

NOTES:

1. AGGREGATE BACKFILL SHALL BE 3/4" CLEAN AGGREGATE (USE CALTRANS SPEC).
2. BOTTOM OF DRY WELL SHALL BE A MINIMUM 10' FROM SEASONAL HIGH GROUNDWATER TABLE.
3. DRY WELL SHALL BE A MINIMUM 100' HORIZONTALLY FROM ANY WATER SUPPLY WELL.

SOURCE:
MODIFIED FROM CONNECTICUT STORMWATER QUALITY MANUAL, 2004

Dry Well Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Infiltration Trench

California Storm Water Quality Handbook (2003)

An infiltration trench is typically long, narrow, and filled with gravel or other permeable material. The trench stores runoff and infiltrates it through the bottom and sides into the subsurface soil. In a variation of this method, perforated drain pipes may convey runoff to gravel-filled trenches and thence into the native soil.

Design and Construction. The Contra Costa Clean Water Program's sizing tool will determine the required minimum area for a designated dry well depth. For treatment-only, the resulting volume is equal to the minimum water-quality volume (California BMP method); for treatment-plus-flow-control, the area is the minimum necessary to ensure runoff does not exceed pre-project rates and durations.

Following excavation, the trench is lined with a geotextile filter fabric. A sand layer is placed on the bottom, and the trench is backfilled with clean, open-graded gravel or rock. A horizontal layer of filter fabric is placed over the gravel or rock before a final surface layer of topsoil, sand or pea gravel. A simple observation well can be fashioned from a footplate, perforated PVC pipe, and a locking cover.

Maintenance. Trenches should be inspected following storms to ensure that water drains within 72 hours. If clogging occurs, it may be necessary to remove and replace the top layer of filter fabric and possibly the coarse aggregate fill.

Best Uses

- Mixed-use and commercial
- Parking lots
- Roof runoff

Advantages

- Simple; low-cost
- Provides disposal as well as treatment

Limitations

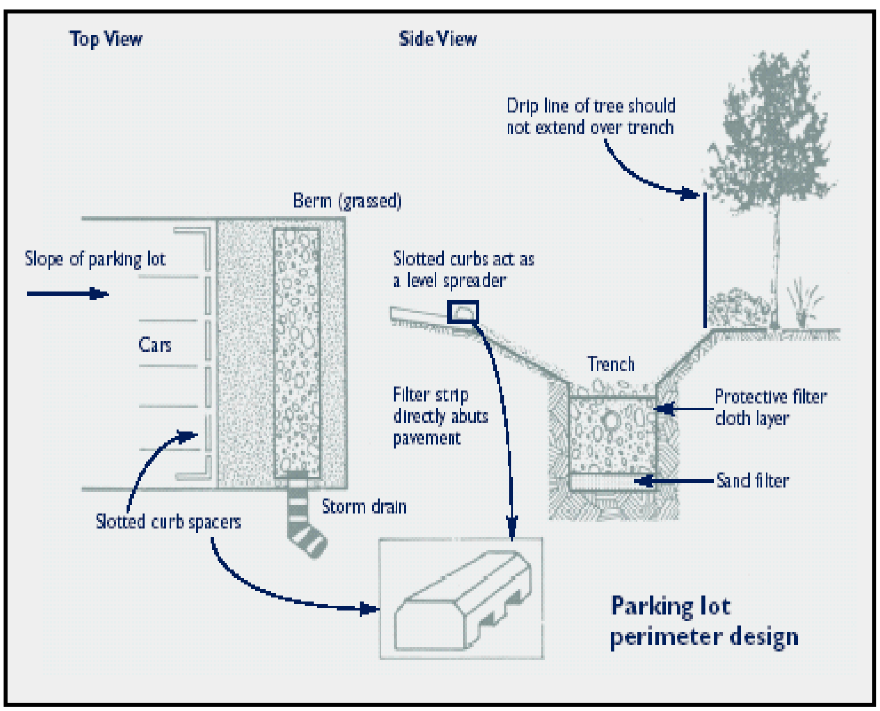
- Generally not appropriate for clayey soils (Hydrologic Soil Groups C & D)
- 10' minimum depth from bottom of trench to seasonal high groundwater
- Not suitable for industrial or "high risk" commercial areas or arterial streets
- Clogging frequency depends on amount of fine sediment in influent

CONTRA COSTA CLEAN WATER PROGRAM

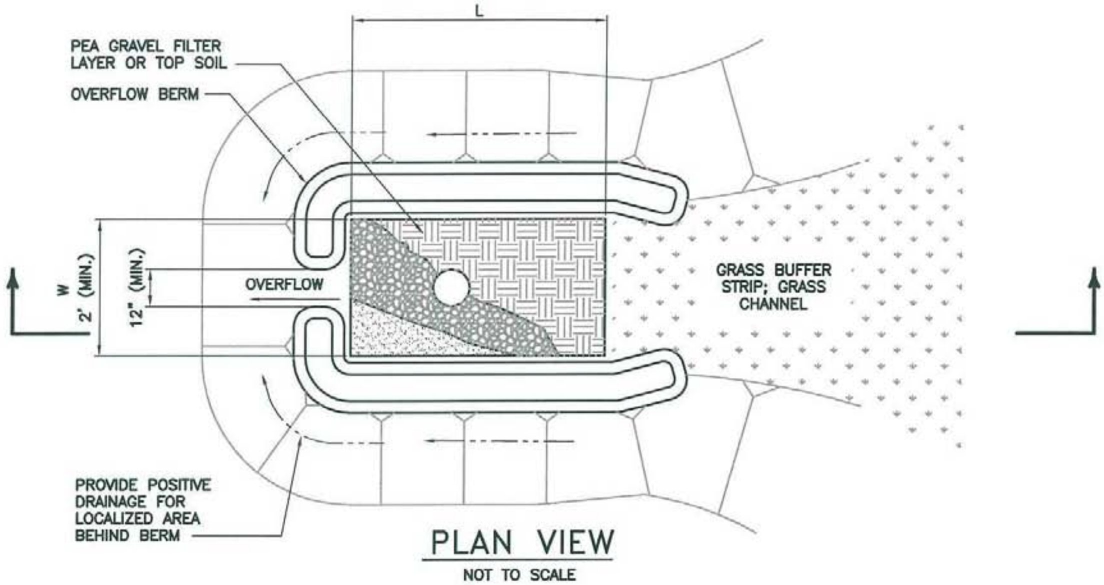
Integrated Management Practice Fact Sheets

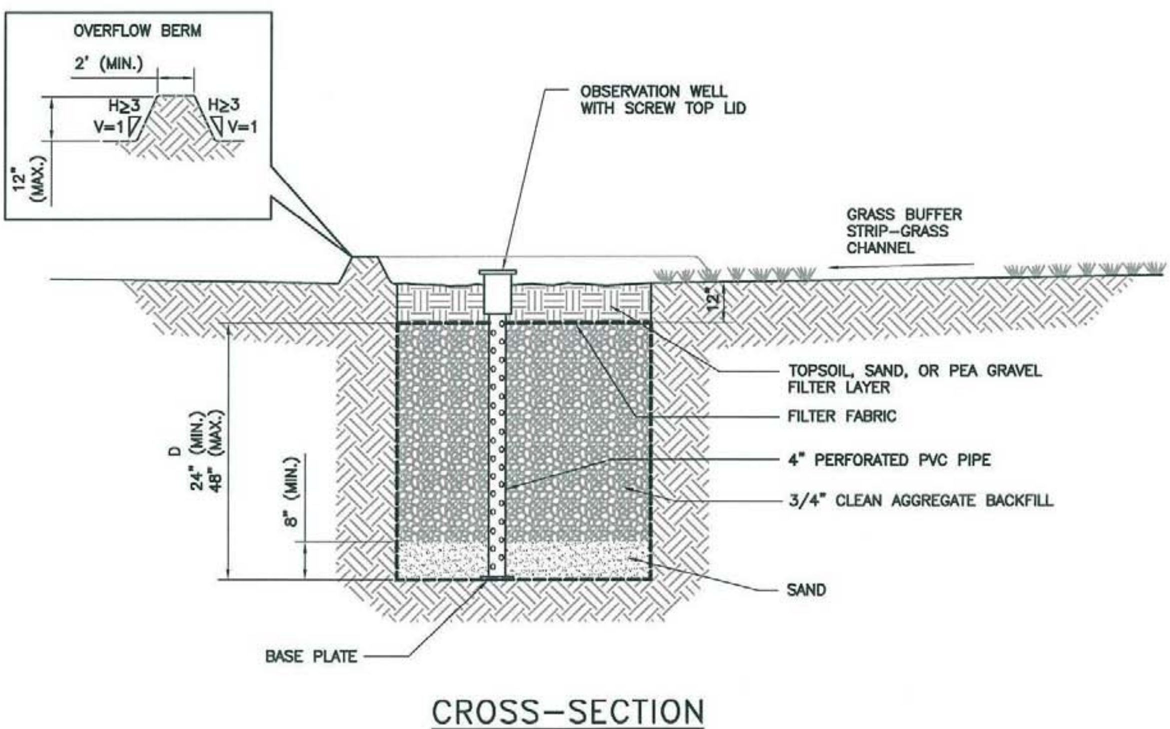
Design Checklist for Infiltration Trench

- ❒ Infiltration trench surface area is at least as large as that determined by the sizing tool for the design depth selected.
- ❒ Depth from bottom of trench to seasonally high groundwater elevation is ≥10'.
- ❒ Areas tributary to the infiltration trench do not include automotive repair shops; car washes; fleet storage areas (bus, truck, etc.); nurseries, or other uses that may present an exceptional threat to groundwater quality.
- ❒ The infiltration trench is separated by at least 100 feet from any adjacent drinking water supply wells.
- ❒ Set back from structures 10' or as required by structural or geotechnical engineer.
- ❒ Areas tributary to the infiltration trench do not exceed 5 acres.
- ❒ Underlying soils are in hydrologic soil group A or B. Infiltration rate is sufficient to ensure a full basin will drain completely within 72 hours. Soil infiltration rate has been confirmed (Attachment C-2).
- ❒ Depth to bedrock is ≥ 3'.
- ❒ All upstream drainage areas are stabilized prior to construction of the infiltration trench.
- ❒ Vegetated strip or other pretreatment has been incorporated where possible.
- ❒ A horizontal layer of filter fabric is installed just below the surface of the trench to retain sediment and to reduce the potential for clogging.
- ❒ Trench backfill is clean drain rock with minimum porosity of 0.4.
- ❒ The sides of the infiltration trench are lined with a geotextile fabric.
- ❒ The infiltration trench is located a minimum of 50 feet away from slopes in excess of 15%.
- ❒ Design includes an observation well.



Young et al. 1996





NOTE:

L = DESIGN LENGTH BASED ON DESIGN INFILTRATION VOLUME AND 3/4" CLEAN AGGREGATE VOID VOLUME.

SOURCE:
MODIFIED FROM CENTER FOR WATERSHED PROTECTION, 2000

Infiltration Trench Detail

Contra Costa Clean Water Program Infiltration Site Characterization Criteria and Guidance Study

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Appendix

D

Flow Control

Instructions and tools for meeting flow-control (hydrograph modification management) requirements.

Provision C.3.f in the stormwater NPDES permit requires Contra Costa municipalities to "manage increases in peak runoff flow and increased volume, for all Group 1 projects, where such increased flow or volume is likely to cause increased erosion of creek beds and banks, silt pollutant generation, or other waterbody impacts to beneficial uses due to increased erosive force."

As required by the NPDES permit, the Program submitted a Hydrograph Modification Management Plan, including a proposed flow-control standard, in July 2005. The Regional Water Board adopted the proposed flow-control standard with minor modifications one year later. See Attachment D-1.

The flow-control standard applies to projects which create or replace one acre or more of impervious area and for which applications for development approvals are deemed complete after October 14, 2006. See Chapter 1, including Table 1-1.

The flow-control standard is preventative: project proponents are encouraged to design their projects so there will be no increase in runoff as compared to the pre-project condition of the development site. The Program has created designs and design aids for Low Impact Development Integrated Management Practices (IMPs) which may be used to achieve this criterion.

Appendix D Contents

However, increased runoff is allowed if it can be demonstrated the increases are unlikely to cause downstream erosion or other impacts on beneficial uses of streams. This may be the case either because the drainage downstream between the project site and the Bay/Delta is in pipes or in channels that are tidally influenced or aggrading. Or the applicant may propose a stream restoration project or projects which fully mitigate the erosion risk.

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Comparison of post-project to pre-project flows is based on continuous simulation of runoff over a period of 30 years or more, using local hourly rainfall data, and statistical analysis of peak flow recurrence and of the cumulative duration of flows. See the discussion in Chapter 2.

To demonstrate compliance with the standard, select one of the following four options:

Option 1. Demonstrate the project produces no net increase in impervious area. A simple inventory and accounting of existing and proposed impervious area is required. You will also need to show, qualitatively, that changes to drainage facilities will not increase the efficiency of drainage collection and conveyance.

Option 2. Implement IMPs such as planters, swales, and bioretention areas using the Program's low-impact development site design procedure and facility sizing tool. Applicable criteria, including runoff factors and IMP sizing ratios, have been selected to meet the flow-control standard and are incorporated into the tool.

Option 3. Use a continuous-simulation hydrologic computer model such as USEPA's Hydrologic Simulation Program—Fortran (HSPF) to simulate pre-project and post-project runoff, including the effect of proposed IMPs, detention basins, or other storwmater management facilities. An hourly rainfall record of at least 30 years must be used. Compile flow statistics and produce summary peak flow and flow duration graphics to demonstrate the following criteria are met:

> For flow rates from 10% of the pre-project 2-year runoff event (0.1Q2) to the pre-project 10-year runoff event (Q10), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10% over more than 10% of the length of the flow duration curve.
>
> For flow rates from 0.5Q2 to Q2, the post project peak flows shall not exceed pre-project peak flows. For flow rates from Q2 to Q10, post-project peak flows may exceed pre-project flows by up to 10% for a 1-year frequency interval. For example, post-project flows could exceed

pre-project flows by up to 10% for the interval from Q9 to Q10 or from Q5.5 to Q6.5, but not from Q8 to Q10.

Option 4. Show that, because of the specific characteristics of the stream receiving runoff from the project site, or because of proposed channel restoration projects, or both, there is little likelihood the cumulative impacts from new development could increase the net rate of stream erosion significantly.

Option 4a. Low Risk. Show all downstream reaches, from the project site to the Bay/Delta, are enclosed pipes, hardened channels, subject to tidal action, or aggrading.

Option 4b. Medium Risk. Use the methods and criteria in this Appendix to confirm each reach downstream from the project to the Bay/Delta meets criteria for the "medium risk" (or "low-risk") classification. Implement an in-stream mitigation project to stabilize stream beds or banks, improve natural stream functions, and/or improve habitat values. The expected environmental benefits of the mitigation project must substantially outweigh the potential impacts of an increase in runoff from the development project.

Option 4c. High Risk. Implement a comprehensive program of in-stream measures to improve stream channel hydrological and ecological functions while accommodating increased flows.

Whichever option is used to demonstrate flow control compliance, projects must also meet the C.3 treatment requirements. Under Option 2, projects can meet both the treatment and flow control requirements by using the low-impact development site design procedure and facility sizing tool. The following sections contain instructions and references to assist you.

Option 1: No increase in impervious area

This option applies to sites which have been previously developed. To use Option 1, simply compare existing to proposed impervious area. You will also need to show, qualitatively, that changes to drainage facilities will not increase the efficiency of drainage collection and conveyance.

► RATIONALE

In many cases, redevelopment of a previously built site will result in decreases in total impervious area—because of setback and landscaping requirements and use of IMPs to treat runoff. Even when sized for stormwater treatment only, IMPs also reduce runoff peaks and durations considerably. The combination of decreased impervious area and IMPs practically assures that post-project runoff will not exceed pre-project peaks and durations.

► MEETING THE REQUIREMENTS

Use a base map or aerial photo.

- Identify existing roofs, paved areas, and other impervious surfaces.
- Delineate the impervious areas, dividing them to facilitate identification of each area and estimation of its square footage.
- Mark each delineated area with a unique identifier and calculated square footage.
- Prepare a table listing each delineated area and its square footage and show a total for the project site.

Refer to the table of areas you prepared for the design of treatment facilities (Chapter 3, Step 5). Sum the impervious areas.

► PREPARING YOUR SUBMITTAL

See the instructions in Chapter 3, Step 2, regarding assessment of site opportunities and constraints to reduce imperviousness and retain or detain site drainage and in Chapter 3, Step 3, regarding design features and surface treatments used to minimize imperviousness. Make sure this information is included in your Stormwater Control Plan.

Include in your Stormwater Control Plan, as an attachment, figure, or exhibit, the marked-up base map or aerial photo showing existing impervious surfaces.

Include in your Stormwater Control Plan the tabulation and sum of existing impervious areas and a comparison to the total proposed impervious area.

If you used the recommended Low Impact Development design procedure (Chapter 5), including sizing IMPs for stormwater treatment only, no further documentation of reduced drainage efficiency is required. If you used a different design procedure to design stormwater treatment facilities, describe the existing and proposed drainage systems and explain, qualitatively or quantitatively:

- Why the time of concentration is increased as a result of the proposed development, and
- Why the total volume of runoff is reduced as a result of the proposed development.

Option 2: Integrated Management Practices

Most applicants will find it easiest and most cost-effective to use this option. Use the Program's Design and Documentation Procedure for Low Impact Development (Chapter 5) and the Program's IMP sizing tool (Appendix I) to select and size swales, planter boxes, bioretention areas, or other IMPs to meet both treatment and flow-control requirements for your project.

► RATIONALE

The Program developed designs (Appendix C) and sizing factors for a variety of IMPs. The sizing factor applicable to a particular IMP is dependent on the soil type and rainfall pattern at the development site. The sizing factors were calculated to ensure runoff discharged from the IMP does not exceed the pre-project peaks and durations of runoff from the area tributary to the IMP. See Chapter Two, Chapter Five, and the Program's Hydrograph Modification Management Plan for more background on calculation of the IMP sizing factors.

► MEETING THE REQUIREMENTS

Follow the instructions in Chapter Five to use the Program's IMP sizing tool (Appendix I), which is available on the Program's C.3 web page. Select the "Treatment and Flow Control" option to size IMPs to provide both treatment and flow control for site runoff.

► PREPARING YOUR SUBMITTAL

Incorporate the output from the Program's IMP sizing tool into your Stormwater Control Plan.

Option 3: Model Pre- and Post-Project Runoff

This option is for applicants who wish to design their own flow-control facilities customized to the needs and character of their development projects. It requires the development of a continuous simulation hydrologic model of the project under pre-project and post-project conditions, including the effect of proposed IMPs, detention basins, or other storwmater management facilities

Building a continuous-simulation hydrologic model for a project, and analyzing its output to compare post-project to pre-project hydrology, may be a better option than the Program's IMP sizing tool:

- When it is proposed to use facilities such as detention basins, constructed wetlands, or other facilities for which the Program has not developed sizing factors.
- For large drainage areas with complex drainage, steep slopes, dense vegetation, thin top soil, or other hydrological conditions where a site-

specific model can provide a better representation of post-project and pre-project hydrology.

Because of the time and resources required to implement this option, it is typically applicable to larger developments (sites greater than 20 acres). However, hydrologic models may also be used to analyze facilities such as rooftop detention, cisterns, or IMPs in series.

Note stormwater treatment requirements are also applicable to projects that select Option 3 to meet the flow control requirements (Table 1-1). Treatment requirements and flow-control requirements can be met via separate facilities in series, or a single facility may be designed for both treatment and flow-control. For example, a pond or wetland can serve as a treatment facility if it detains the required water quality volume for 48 hours and contains suitable design elements. To show the same pond or wetland also meets flow-control requirements, the applicant would need to construct a computer model to compare post-project to pre-project hydrology on the development site, including the hydrologic effects of the proposed pond or wetland.

Development of continuous simulation hydrologic model for a specific development site requires specialized expertise and substantial resources. Municipal staff may require the applicant to establish a force account or similar financial mechanism to provide for independent, third-party review of model documentation and output. Engineering and other design considerations related to flow-control may need to be coordinated with considerations related to flood protection and controlling other potential environmental impacts of the development.

Consult with municipal staff before beginning work on a computer model, and coordinate implementation with environmental agencies from which project approvals must be obtained.

► RATIONALE

Conventionally, drainage facilities have been designed to accommodate peak flows or volumes generated by a specific hypothetical rainfall event (design storm). The design storm is typically characterized by its recurrence interval (e.g., a 10-year or 100-year storm). Conventional drainage facilities, including flood-control basins, are designed for protection from flooding, not to protect streams from erosion.

As regulatory agencies began to develop criteria to protect streams from accelerated erosion caused by urbanization and increased imperviousness, many agencies limited the allowable increase in peak discharge associated with a specific design storm. The science of fluvial geomorphology showed that, for stable streams in undeveloped watersheds, the "channel forming flow"—the event with the most capability to move sediment—recurred approximately every 1-2 years. Initial criteria for stream protection focused on designing facilities to control peak flows from runoff events at and near this magnitude.

Further analysis of urbanizing streams indicated increases in the frequency and duration of lower flows can also contribute to accelerated stream erosion. Rainfall events which would produce little or no runoff in a pre-development watershed produce significant runoff from impervious surfaces—and that runoff is typically piped directly to streams. To fully protect streams in urbanizing watersheds from accelerated erosion, it may be necessary to control the entire regime of large and small flows.

Continuous simulation models, which typically use as input hourly rainfall data over 30 years or more, can simulate the entire runoff flow regime under existing and post-project conditions. Two sets of criteria are generally used to compare modeled pre-project and post-project flows over the long term: peak flows for each event contained in the simulation, and duration of flows at the full range of simulated flow rates. See Figures 5-4 and 5-5.

Regardless of the hydrologic calculation method used, estimation of runoff from a particular development site requires selection of appropriate parameters to represent the quantity of rainfall that runs off versus that which puddles, infiltrates into the ground, or is absorbed by vegetation. The rational method uses "C" factors and the SCS methodology uses curve numbers to represent these relationships. Continuous simulation models, such as USEPA's Hydrologic Simulation Program—Fortran (HSPF), use a more complex suite of parameters to characterize soils and vegetation. Values for these parameters can be calibrated to stream flow data for whole watersheds. For individual development sites, or where stream flow data is not available, appropriate values for each parameter must be estimated.

► MEETING THE REQUIREMENTS

After discussing the process for technical review with municipal staff, build and run a continuous-simulation hydrologic model of the existing site and the proposed development including detention/retention facilities. Procedures and parameters must be consistent with the instructions in Attachment D-2. Prepare a statistical analysis of the results as described in Attachment D-2 and illustrated in Figures 5-4 and 5-5.

► PREPARING YOUR SUBMITTAL

Provide a detailed report on the hydrologic modeling that includes, at a minimum:

- An **introduction** that provides a description of existing site conditions, land uses and land cover and a description of the proposed project.

- Separate **site maps** for pre-project and post-project conditions. The site maps should delineate the sub-basins used to characterize the site within the model under pre-project and post-project conditions and show a basin number or other identifier for each sub-basin. Show on your maps: hydraulic structures, roadways, drainageways, stormwater management facilities, and topography; the post-project map should also include proposed grading and site layout.

- An estimate of the Mean Seasonal Precipitation at the project site and identification of the long-term rainfall data set used in the simulation. The data should be from the Contra Costa gauge site with the most similar mean seasonal precipitation to the project site, as indicated by the Contra Costa County Public Works Department Mean Seasonal Isohyets Map (rainfall data and Isohyetal map available on the Program's web site).

- A table of model parameters used to characterize each sub-basin shown on the pre-project and post-project site maps. The table should include the sub-basin identifier, total basin area, pervious area, impervious area, NRCS soil type, and other model parameters used to define infiltration and runoff characteristics of the sub-basin. Applicants submitting an HSPF hydrologic analysis should include PWATER parameter values for each pervious land segment. (Common HSPF parameter values are provided in Appendix A of attachment D-2.)

- A detailed description of proposed facilities for stormwater treatment and flow control. Describe the type of facility, design dimensions, overflow capacity, underdrain sizing parameters (control device), emergency overflow route, and any other hydraulic controls. Describe how the facilities were characterized in the model and methods used for facility sizing; if IMPs are modeled, include a detailed discussion of the assumed water movement hydraulics describing infiltration, soil water storage, and soil water movement. Provide a sketch of each facility showing key hydraulic design elements such as orifice sizing and placement.

- A table of model parameters used to characterize proposed stormwater management facilities, such as FTABLEs (HSPF), rating curves etc.

- A description of runoff routing that explains how runoff from each sub-basin is routed through the project site. For sub-basins which drain to a single stormwater management facility, a discussion of the basin routing is sufficient. For more complex sub-basins or series of sub-basins, with explicit routing, provide a **table** describing the reach parameters and transform methods in addition to the detailed routing description. (Routing parameters will vary depending on hydrologic model and routing method selected.)

- Modeling results, summarized as partial duration statistics and flow duration tables. To compute partial duration statistics and separate the long-term HSPF output time series into discrete storm events, use a 24 hour period with flows less than 0.02 cfs per acre to signify the end of an event. The partial duration statistics table should list for each flow event: start date, event duration, peak flow, flow volume and recurrence interval. Peak flow frequency and flow duration curves that illustrate the proposed project meets the peak flow control and flow duration control standard (as outlined in Attachment D-2).

Option 4a: Low Risk of Accelerated Erosion

This option may be applicable if your project is in low-elevation areas near the Bay/Delta or an adjacent urbanized area drained by underground pipes or hardened channels. It is the responsibility of the applicant to demonstrate all downstream channels between the project site and the Bay/Delta meet the "low risk" criteria.

► RATIONALE

Flow control is not necessary if it can be demonstrated that increased flow peaks and durations would have no effect on downstream channels. "No effect" can be stipulated if it is demonstrated that the entire drainage route from the site to the Bay/Delta is in pipes, engineered hardened channels, channels subject to tidal action, or channels subject to accumulation of sediments.

For some projects, this demonstration can be a simple reference to municipal storm drain maps (for example). However, drainage channels, particularly small channels, are not always well documented. Even where drainage is documented, the boundaries of areas tributary to the drainage may be difficult to discern. For this reason, Contra Costa has not prepared a comprehensive map showing where Option 4a applies. Where necessary, applicants may need to provide field notes, photographs, or other documentation to verify the characteristics of specific reaches along the route between their project site and the Bay/Delta.

Many reaches of Contra Costa's major creeks are natural or unhardened; Option 4a cannot be used to establish compliance with flow-control requirements for projects upstream of these reaches.

► MEETING THE REQUIREMENTS

Trace the drainage route from the project site down to the Bay/Delta. Divide the route into reaches based on the type and characteristics of drainage structures (pipe, engineered channel, natural channel). Assemble documentation and confirm each reach is in one of the following categories:

1. Enclosed pipe.

2. Channel with continuous hardened beds and banks engineered to withstand erosive forces and composed of concrete, engineered riprap, sackcrete, gabions, mats, etc. (Channel hardening must be an

TABLE D-1. Suggested format for presentation of reach-by-reach information for "low risk" (Option 4a).

Reach ID	*Description*	*"Low Risk" Category*	*Reference or documentation*

engineered continuous installation and not piecemealed in response to localized bank failure and erosion.)

3. Channel subject to tidal action.

4. Channel which is aggrading, i.e. consistently subject to accumulation over decades and with no indicators on erosion on the channel banks.

► PREPARING YOUR SUBMITTAL

Your report, signed by an engineer or qualified environmental professional, should include as necessary a map or diagram showing each reach, a narrative briefly describing the reaches in order from site to Bay/Delta, and a tabulated presentation of the documentation used to confirm the status of each reach. The format illustrated in Table D-1 can be used.

You can facilitate review of your submittal by attaching photocopies of, or providing links to, the key source materials used to establish each "low risk" classification. Examples of sources are in Table D-2.

TABLE D-2. Examples of source materials which could document "low risk" (Option 4a).

	"Low Risk" Category	*Examples of Source Materials*
1	Enclosed pipes	Municipal storm drain map or personal communication with municipal staff
2	Channel with continuous hardened beds and banks	Project name or number for original construction of the channel, or personal communication with staff of the agency responsible for channel maintenance, or field reconnaissance.
3	Tidally influenced channel	Elevation of outfall to channel (from construction drawings or field reconnaissance), or personal communication with Flood Control District staff.
4	Aggrading channel	Visual survey by a qualified geomorphologist or personal communication with Flood Control District staff confirming the history of sediment accumulation and removal.

Option 4b: Medium Risk of Accelerated Erosion

This option allows an applicant, in certain cases, to mitigate potential effects of increased runoff on a stream reach by sponsoring a bed or bank restoration project of limited scope.

The option is only available to projects smaller than 20 acres total area.

The applicant must first confirm downstream reaches have characteristics indicating channel beds and banks are, in the main, relatively resistant to accelerated erosion from increased runoff.

The applicant must then have a qualified geomorphologist confirm this finding and develop a proposal for a mitigation project, the benefits of which must substantially outweigh potential impacts of an increase in runoff from the proposed development project.

The applicant must also obtain concurrence from staff of regulatory agencies having jurisdiction—including Regional Water Board staff—that the mitigation project is feasible and desirable.

► RATIONALE

In a "medium risk" stream reach, the channel is stable under current conditions and may be able to absorb a slight increase in watershed imperviousness, but accelerated erosion cannot be ruled out. For some development projects upstream of these reaches, flow-control facilities may be costly or difficult to build, and the resulting benefit may be uncertain and small.

Detailed studies of the potential effects of a development on a stream can be costly, time consuming, and (in the case of a "medium risk" stream reach) could simply reiterate that increased erosion is not likely, but is possible.

As an alternative to extensive study of the stream, applicants have the option of proposing a mitigation project. Contra Costa streams have a substantial backlog of needed (but unfunded) maintenance to prevent or repair localized bank failures. Properly designed and executed, localized restoration projects can have substantial environmental benefits. Mitigation projects should seek to attenuate or reduce excessive erosive stresses (for example, by increasing channel cross section or reducing gradient), rather than just increasing shear resistance by stabilizing banks.

The benefits of the mitigation project must substantially outweigh the incremental increase in the risk of erosion due to the increased runoff represented by the project. This balance is established by the opinion of a qualified geomorphologist and then confirmed by consensus among staff of the agencies having jurisdiction.

Program consultants outlined a process and created technical tools applicants may use to implement this option. To begin the process, an engineer or qualified environmental professional can use the Program's Basic Geomorphic Assessment procedure (Attachment D-3) to evaluate downstream reaches and show each reach is either "low risk" (see Option 4a) or "medium risk."

► MEETING THE REQUIREMENTS

Implementation of Option 4b proceeds in two phases. In the first phase, an engineer or qualified environmental professional makes a preliminary determination whether all reaches of drainage downstream from the project site to the Bay/Delta are either "low risk" or "medium risk" according to the Program's criteria. If this determination is affirmative, the applicant may proceed to the second phase, in which a qualified stream geomorphologist confirms the preliminary determination and proposes an appropriate mitigation project.

Applicants are strongly encourage to coordinate with municipal staff, staff of the Contra Costa Flood Control and Water Conservation District, property owners of stream reaches and adjacent parcels, and regulatory agencies having jurisdiction (including the Regional Water Board and the California Department of Fish and Game) during the first phase and/or before proceeding the second phase.

First phase (conducted by an engineer, stream geomorphologist, or other qualified environmental professional): As in Option 4a, trace the drainage route from the project site down to the Bay/Delta. Divide the route into reaches based on the type and characteristics of drainage structures. Identify and assemble documentation for any "low risk" reaches as in Option 4a.

Conduct the field site review and collect the field data described in the Basic Geomorphic Assessment procedure (Attachment D-3) to each of the remaining reaches downstream to the point where:

- all further downstream reaches are "low risk," or
- the channel enters a publicly managed reservoir.

For each of these reaches, complete a Geomorphic Assessment Form, including field notes and photographs, to calculate the channel vulnerability indicators and evaluate the appropriate risk class. Write a narrative risk justification to accompany each assessment form.

Second phase (conducted by a qualified stream geomorphologist): Confirm the findings of the preliminary report using the information in the assessment forms, additional field data, and other available information.

Identify and describe a suitable mitigation project to stabilize stream beds or banks, improve natural stream functions, and/or improve habitat values. If a suitable project exists in the same stream reach or watershed, that project should be proposed; otherwise, a project in another watershed may be acceptable.

► PREPARING YOUR SUBMITTAL

Prepare a preliminary plan and proposal for the mitigation project including milestones, schedule, cost estimates, and funding. Include a written commitment from the developer or project proponent to implement the mitigation project timely in connection with the proposed development project.

Provide an opinion and supporting analysis by one or more qualified environmental professionals that the expected environmental benefits of the mitigation project substantially outweigh the potential impacts of an increase in runoff from the development project.

To complete documentation of compliance with flow-control requirements under Option 4b, obtain letters or meeting notes in which staff representatives of regulatory agencies having jurisdiction state the project is feasible and desirable. This must include a letter signed by the Regional Water Board Executive Officer or designee referencing this requirement.

Option 4c: High Risk of Accelerated Erosion

As noted at the beginning of this appendix, the Program's flow-control standard is preventative: project proponents are encouraged to design their projects so that there will be no increase in runoff as compared to the pre-project condition of the development site. This policy aims to ensure watershed-wide increases in runoff and the attendant impacts are minimized, while obviating the need for extensive analysis to characterize the complex and unpredictable relationship between increased runoff and accelerated stream erosion in a particular watershed.

However, where it is very difficult or infeasible to achieve no increase in runoff—or in cases where a stream channel is to be restored as mitigation for other environmental impacts—an applicant may propose to alter the receiving stream channel to accommodate the predicted post-project flow regime.

The analysis required to determine design objectives for in-stream measures will typically involve watershed-scale continuous hydrologic modeling of pre-project and post-project runoff flows, sediment transport modeling, collection and/or analysis of field data to characterize channel morphology including analysis of bed and bank materials and bank vegetation, selection and design of in-stream structures, and project environmental permitting.

► RATIONALE

Stream channels which do not meet the criteria for "low-risk" (Option 4a) or "medium-risk" (Option 4b) are considered at "high-risk" of accelerated erosion due to increased watershed imperviousness. High risk channels are geomorphically unstable under existing conditions, and therefore vulnerable to any increase in impervious area.. It is presumed that increases in runoff flows to these channels will accelerate bed and bank erosion.

If downstream drainage includes high-risk channels, the applicant must either control runoff flows to pre-project peaks and durations or propose a comprehensive program of in-stream measures to improve channel functions while accommodating increased flows.

► MEETING THE REQUIREMENTS

To obtain approval for a project which discharges increased runoff peaks and durations to a high-risk channel, the project proponent must perform a comprehensive analysis to determine the design objectives for channel restoration and must propose a comprehensive program of in-stream measures to improve channel functions while accommodating increased flows. Specific requirements are developed case-by-case in consultation with regulatory agencies having jurisdiction.

Different project types, channels, and locations will demand different investigative approaches; however, the following framework can be tailored to most situations:

- Evaluation of watershed historic conditions.
- Evaluation of channel geomorphic conditions.
- Evaluation of project impacts on hydrology and sediment yield.
- Prediction of impacts on receiving channels.
- Design of avoidance or mitigation.
- Monitoring and adaptive management.

Attachment D-3 includes additional detail regarding this framework and recommended evaluation method and design methods.

► PREPARING YOUR SUBMITTAL

The analysis for compliance with flow-control requirements may, and in many cases should be, integrated with analyses conducted pursuant to obtaining Clean Water Act Section 401 or Section 404 certification, CEQA, California Department of Fish and Game Stream Alteration Permits, and other regulatory approvals which may be required for the development project or implementation of in-stream measures, or both.

Discuss the contents of required submittals with the staff of agencies having jurisdiction prior to the start of the analytical work.

References and Resources

- Appendix I, Facilities Sizing Tool
- Regional Water Quality Control Board Order R2-2006-0050, adding Hydrograph Modification Management Requirements
- *Contra Costa Clean Water Program Final Hydrograph Modification Management Plan,* May 15, 2005

I. Hydrograph Modification Management Standard

All projects subject to this Standard[1] shall ensure estimated post-project runoff peaks and durations do not exceed estimated pre-project peaks and durations if increased stormwater runoff peaks or durations could cause erosion or other significant effects on beneficial uses.[2]

By allowing no increase or impact from any individual project, the standard is intended to ensure that beneficial uses are reasonably protected from the potential cumulative effects of future development in the same watershed. In addition, each of the following methods and criteria for demonstrating compliance with the standard is defined using conservative criteria (e.g., by using an upward bias when assessing and estimating potential impacts of hydrograph modification and a downward bias when estimating the effectiveness of hydrograph modification management measures). Finally, the methods and criteria emphasize distributed, infiltration-based integrated management practices (IMPs) that mimic natural infiltration processes, minimizing the potential for cumulative impacts.

II. Demonstrating Compliance with the Standard

Project proponents shall demonstrate compliance with the standard by demonstrating that any one of the following four options is met:

1. **No increase in impervious area.** The project proponent may compare the project design to the pre-project condition and show the project will not increase impervious area and also will not facilitate the efficiency of drainage collection and conveyance. The comparison shall include all of the following:
   a. Assessment of site opportunities and constraints to reduce imperviousness and retain or detain site drainage.
   b. Description of proposed design features and surface treatments used to minimize imperviousness.
   c. Inventory and accounting of existing and proposed impervious areas.
   d. A qualitative comparison of pre-project to post-project efficiency of drainage collection and conveyance that demonstrates that opportunities to decrease imperviousness and retain / detain runoff have been maximized. Stormwater treatment IMPs such as those in the *Stormwater C.3 Guidebook* increase time of concentration, particularly for smaller storms, and are considered to substantially reduce drainage efficiency.
2. **Implementation of hydrograph modification IMPs.** The project proponent may select and size IMPs to manage hydrograph modification impacts, using the design procedure, criteria, and sizing factors specified in the Contra Costa Clean Water Program's *Stormwater C.3 Guidebook*. The use of flow-through planters shall be limited to upper-story plazas, adjacent to building foundations, on slopes where infiltration could impair geotechnical stability, or in similar

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[1] This Standard will apply only to projects that create or replace one acre or more of impervious surface until such time as this size threshold is changed through such mechanisms as a region-wide permit, a blanket permit amendment for all Bay Area Permittees, or through reissuance of the Dischargers' permit accomplished in a consistent fashion with the other Bay Area Permittees.
[2] This is a restatement of Water Board Order R2-2003-0022, Provision C.3.f.i.

situations where geotechnical issues prevent use of IMPs that allow infiltration to native soils. Limited soil infiltration capacity in itself does not make use of other IMPs infeasible.

3. **Estimated post-project runoff durations and peak flows do not exceed pre-project durations and peak flows.** The project proponent may use a continuous simulation hydrologic computer model such as USEPA's Hydrograph Simulation Program—Fortran (HSPF) to simulate pre-project and post-project runoff, including the effect of proposed IMPs, detention basins, or other stormwater management facilities. To use this method, the project proponent shall compare the pre-project and post-project model output for a rainfall record of at least 30 years, using limitations and instructions provided in the Program's *Stormwater C.3 Guidebook*, and shall show the following criteria are met:

   a. For flow rates from 10% of the pre-project 2-year runoff event (0.1Q2) to the pre-project 10-year runoff event (Q10), the post-project discharge rates and durations shall not deviate above the pre-project rates and durations by more than 10% over more than 10% of the length of the flow duration curve.

   b. For flow rates from 0.5Q2 to Q2, the post-project *peak flows* shall not exceed pre-project peak flows. For flow rates from Q2 to Q10, post-project peak flows may exceed pre-project flows by up to 10% for a 1-year frequency interval. For example, post-project flows could exceed pre-project flows by up to 10% for the interval from Q9 to Q10 or from Q5.5 to Q6.5, but not from Q8 to Q10.

4. **Projected increases in runoff peaks and durations will not accelerate erosion of receiving stream reaches.** The project proponent may show that, because of the specific characteristics of the stream receiving runoff from the project site, or because of proposed stream restoration projects, or both, there is little likelihood that the cumulative impacts from new development could increase the net rate of stream erosion to the extent that beneficial uses would be significantly impacted. To use this option, the project proponent shall evaluate the receiving stream to determine the relative risk of erosion impacts and take the appropriate actions as described below and in Table A-1. Projects 20 acres or larger in total area shall not use the medium risk methodology in "b" below.

   a. **"Low Risk."** In a report or letter report, signed by an engineer or qualified environmental professional, the project proponent shall show that all downstream channels between the project site and the Bay/Delta fall into one of the following "low-risk" categories.

      i. Enclosed pipes.

      ii. Channels with continuous hardened beds and banks engineered to withstand erosive forces and composed of concrete, engineered riprap, sackcrete, gabions, mats, etc. This category excludes channels where hardened beds and banks are not engineered continuous installations (i.e., have been installed in response to localized bank failure or erosion).

      iii. Channels subject to tidal action.

      iv. Channels shown to be aggrading, i.e., consistently subject to accumulation of sediments over decades, and to have no indications of erosion on the channel banks.

   b. **"Medium Risk."** Medium risk channels are those where the boundary shear stress could exceed critical shear stress as a result of hydrograph modification, but where either the sensitivity of the boundary shear stress to flow is low (e.g., an oversized channel with high width to depth ratios) or where the resistance of the channel materials is relatively high (e.g., cobble or boulder beds and vegetated banks). In "medium-risk" channels, accelerated erosion due to increased watershed imperviousness is not likely but is possible, and the uncertainties can be more easily and effectively addressed by mitigation than by additional study.

In a preliminary report, the project proponent's engineer or qualified environmental professional will apply the Program's "Basic Geomorphic Assessment"[3] methods and criteria to show each downstream reach between the project site and the Bay/Delta is either at "low-risk" or "medium-risk" of accelerated erosion due to watershed development. In a following, detailed report, a qualified stream geomorphologist[4] will use the Program's Basic Geomorphic Assessment methods and criteria, available information, and current field data to evaluate each "medium-risk" reach. For *each* "medium-risk" reach, the detailed report shall show one of the following:

i. A detailed analysis, using the Program's criteria, showing the particular reach may be reclassified as "low-risk."

ii. A detailed analysis, using the Program's criteria, confirming the "medium-risk" classification, and:

   1. A preliminary plan for a mitigation project for that reach to stabilize stream beds or banks, improve natural stream functions, and/or improve habitat values, and
   2. A commitment to implement the mitigation project timely in connection with the proposed development project (including milestones, schedule, cost estimates, and funding), and
   3. An opinion and supporting analysis by one or more qualified environmental professionals that the expected environmental benefits of the mitigation project substantially outweigh the potential impacts of an increase in runoff from the development project, and
   4. Communication, in the form of letters or meeting notes, indicating consensus among staff representatives of regulatory agencies having jurisdiction that the mitigation project is feasible and desirable. In the case of the Regional Water Board, this must be a letter, signed by the Executive Officer or designee, specifically referencing this requirement. (This is a preliminary indication of feasibility required as part of the development project's Stormwater Control Plan. All applicable permits must be obtained before the mitigation project can be implemented.)

c. **"High Risk."** High-risk channels are those where the sensitivity of boundary shear stress to flow is high (e.g., incised or entrenched channels, channels with low width-to-depth ratios, and narrow channels with levees) or where channel resistance is low (e.g., channels with fine-

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[3] Contra Costa Clean Water Program *Hydrograph Modification Management Plan*, May 15, 2005, Attachment 4, pp. 6-13. This method must be made available in the Program's *Stormwater C.3 Guidebook*.

[4] Typically, detailed studies will be conducted by a stream geomorphologist retained by the lead agency (or, on the lead agency's request, another public agency such as the Contra Costa County Flood Control and Water Conservation District) and paid for by the project proponent.

grained, erodible beds and banks, or with little bed or bank vegetation). In a "high-risk" channel, it is presumed that increases in runoff flows will accelerate bed and bank erosion.

To implement this option (i.e., to allow increased runoff peaks and durations to a high-risk channel), the project proponent must perform a comprehensive analysis to determine the design objectives for channel restoration and must propose a comprehensive program of in-stream measures to improve channel functions while accommodating increased flows. Specific requirements are developed case-by-case in consultation with regulatory agencies having jurisdiction. The analysis will typically involve watershed-scale continuous hydrologic modeling (including calibration with stream gauge data where possible) of pre-project and post-project runoff flows, sediment transport modeling, collection and/or analysis of field data to characterize channel morphology including analysis of bed and bank materials and bank vegetation, selection and design of in-stream structures, and project environmental permitting.

Attachment D-2

HSPF Modeling Guidance

Attachment D-3

Stream Classification Methodology

Attachments D-2 and D-3 can be accessed from the *Stormwater C.3 Guidebook* section of the Contra Costa Clean Water Program's C.3 web page at www.cccleanwater.org/construction/nd.php.

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

How to use this worksheet (also see instructions on pages 34-35 of the *Stormwater C.3 Guidebook*):

1. Review Column 1 and identify which of these potential sources of stormwater pollutants apply to your site. Check each box that applies.
2. Review Column 2 and incorporate all of the corresponding applicable BMPs in your Stormwater Control Plan drawings.
3. Review Columns 3 and 4 and incorporate all of the corresponding applicable permanent controls and operational BMPs in a table in your Stormwater Control Plan. Use the format shown in Table 3-1 on page 35 of the *Guidebook*. Describe your specific BMPs in an accompanying narrative, and explain any special conditions or situations that required omitting BMPs or substituting alternative BMPs for those shown here.

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ A. **On-site storm drain inlets**	❑ **Locations of inlets.**	❑ **Mark all inlets with the words "No Dumping! Flows to Bay" or similar.**	❑ **Maintain and periodically repaint or replace inlet markings.** ❑ **Provide stormwater pollution prevention information to new site owners, lessees, or operators.** ❑ **See applicable operational BMPs in Fact Sheet SC-44, "Drainage System Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ❑ **Include the following in lease agreements: "Tenant shall not allow anyone to discharge anything to storm drains or to store or deposit materials so as to create a potential discharge to storm drains."**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ B. **Interior floor drains and elevator shaft sump pumps**		❑ **State that interior floor drains and elevator shaft sump pumps will be plumbed to sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ C. **Interior parking garages**		❑ **State that parking garage floor drains will be plumbed to the sanitary sewer.**	❑ **Inspect and maintain drains to prevent blockages and overflow.**
❑ D1. **Need for future indoor & structural pest control**		❑ **Note building design features that discourage entry of pests.**	❑ **Provide Integrated Pest Management information to owners, lessees, and operators.**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ D2. **Landscape/ Outdoor Pesticide Use**	❑ **Show locations of native trees or areas of shrubs and ground cover to be undisturbed and retained.** ❑ **Show self-retaining landscape areas, if any.** ❑ **Show stormwater treatment and hydrograph modification management BMPs. (See instructions in Chapter 3, Step 5 and guidance in Chapter 5.)**	**State that final landscape plans will accomplish all of the following.** ❑ **Preserve existing native trees, shrubs, and ground cover to the maximum extent possible.** ❑ **Design landscaping to minimize irrigation and runoff, to promote surface infiltration where appropriate, and to minimize the use of fertilizers and pesticides that can contribute to stormwater pollution.** ❑ **Where landscaped areas are used to retain or detain stormwater, specify plants that are tolerant of saturated soil conditions.** ❑ **Consider using pest-resistant plants, especially adjacent to hardscape.** ❑ **To insure successful establishment, select plants appropriate to site soils, slopes, climate, sun, wind, rain, land use, air movement, ecological consistency, and plant interactions.**	❑ **Maintain landscaping using minimum or no pesticides.** ❑ **See applicable operational BMPs in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com** ❑ **Provide IPM information to new owners, lessees and operators.**
❑ E. **Pools, spas, ponds, decorative fountains, and other water features.**	❑ **Show location of water feature and a sanitary sewer cleanout in an accessible area within 10 feet. (Exception: Public pools must be plumbed according to County Department of Environmental Health Guidelines.)**	**If the local municipality requires pools to be plumbed to the sanitary sewer, place a note on the plans and state in the narrative that this connection will be made according to local requirements.**	❑ **See applicable operational BMPs in Fact Sheet SC-72, "Fountain and Pool Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ F. **Food service**	❑ **For restaurants, grocery stores, and other food service operations, show location (indoors or in a covered area outdoors) of a floor sink or other area for cleaning floor mats, containers, and equipment.** ❑ **On the drawing, show a note that this drain will be connected to a grease interceptor before discharging to the sanitary sewer.**	❑ **Describe the location and features of the designated cleaning area.** ❑ **Describe the items to be cleaned in this facility and how it has been sized to insure that the largest items can be accommodated.**	❑ **See the brochure, "Water Pollution Prevention Tips to Protect Water Quality and Keep Your Food Service Facility Clean." Provide this brochure to new site owners, lessees, and operators.**
❑ G. **Refuse areas**	❑ **Show where site refuse and recycled materials will be handled and stored for pickup. See local municipal requirements for sizes and other details of refuse areas.** ❑ **If dumpsters or other receptacles are outdoors, show how the designated area will be covered, graded, and paved to prevent run-on and show locations of berms to prevent runoff from the area.** ❑ **Any drains from dumpsters, compactors, and tallow bin areas shall be connected to a grease removal device before discharge to sanitary sewer.**	❑ **State how site refuse will be handled and provide supporting detail to what is shown on plans.** ❑ **State that signs will be posted on or near dumpsters with the words "Do not dump hazardous materials here" or similar.**	❑ **State how the following will be implemented:** **Provide adequate number of receptacles. Inspect receptacles regularly; repair or replace leaky receptacles. Keep receptacles covered. Prohibit/prevent dumping of liquid or hazardous wastes. Post "no hazardous materials" signs. Inspect and pick up litter daily and clean up spills immediately. Keep spill control materials available on-site. See Fact Sheet SC-34, "Waste Handling and Disposal" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ H. **Industrial processes.**	❑ **Show process area.**	❑ **If industrial processes are to be located on site, state: "All process activities to be performed indoors. No processes to drain to exterior or to storm drain system."**	❑ **See Fact Sheet SC-10, "Non-Stormwater Discharges" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**
❑ I. **Outdoor storage of equipment or materials. (See rows J and K for source control measures for vehicle cleaning, repair, and maintenance.)**	❑ **Show any outdoor storage areas, including how materials will be covered. Show how areas will be graded and bermed to prevent run-on or run-off from area.** ❑ **Storage of non-hazardous liquids shall be covered by a roof and/or drain to the sanitary sewer system, and be contained by berms, dikes, liners, or vaults.** ❑ **Storage of hazardous materials and wastes must be in compliance with the local hazardous materials ordinance and a Hazardous Materials Management Plan for the site.**	**Include a detailed description of materials to be stored, storage areas, and structural features to prevent pollutants from entering storm drains.** **Where appropriate, reference documentation of compliance with the requirements of Contra Costa Hazardous Materials Programs for:** ▪ **Hazardous Waste Generation** ▪ **Hazardous Materials Release Response and Inventory** ▪ **California Accidental Release (CalARP)** ▪ **Aboveground Storage Tank** ▪ **Uniform Fire Code Article 80 Section 103(b) & (c) 1991** ▪ **Underground Storage Tank** **www.cchealth.org/groups/hazmat/**	❑ **See the Fact Sheets SC-31, "Outdoor Liquid Container Storage" and SC-33, "Outdoor Storage of Raw Materials " in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ J. **Vehicle and Equipment Cleaning**	❑ **Show on drawings as appropriate:** **(1) Commercial/industrial facilities having vehicle/equipment cleaning needs shall either provide a covered, bermed area for washing activities or discourage vehicle/equipment washing by removing hose bibs and installing signs prohibiting such uses.** **(2) Multi-dwelling complexes shall have a paved, bermed, and covered car wash area (unless car washing is prohibited on-site and hoses are provided with an automatic shut-off to discourage such use).** **(3) Washing areas for cars, vehicles, and equipment shall be paved, designed to prevent run-on to or runoff from the area, and plumbed to drain to the sanitary sewer.** **(4) Commercial car wash facilities shall be designed such that no runoff from the facility is discharged to the storm drain system. Wastewater from the facility shall discharge to the sanitary sewer, or a wastewater reclamation system shall be installed.**	❑ **If a car wash area is not provided, describe measures taken to discourage on-site car washing and explain how these will be enforced.**	**Describe operational measures to implement the following (if applicable):** ❑ **Washwater from vehicle and equipment washing operations shall not be discharged to the storm drain system.** ❑ **Car dealerships and similar may rinse cars with water only.** **See Fact Sheet SC-21, "Vehicle and Equipment Cleaning," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ K. **Vehicle/Equipment Repair and Maintenance**	❑ **Accommodate all vehicle equipment repair and maintenance indoors. Or designate an outdoor work area and design the area to prevent run-on and runoff of stormwater.** ❑ **Show secondary containment for exterior work areas where motor oil, brake fluid, gasoline, diesel fuel, radiator fluid, acid-containing batteries or other hazardous materials or hazardous wastes are used or stored. Drains shall not be installed within the secondary containment areas.** ❑ **Add a note on the plans that states either (1) there are no floor drains, or (2) floor drains are connected to wastewater pretreatment systems prior to discharge to the sanitary sewer and an industrial waste discharge permit will be obtained.**	❑ **State that no vehicle repair or maintenance will be done outdoors, or else describe the required features of the outdoor work area.** ❑ **State that there are no floor drains or if there are floor drains, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.** ❑ **State that there are no tanks, containers or sinks to be used for parts cleaning or rinsing or, if there are, note the agency from which an industrial waste discharge permit will be obtained and that the design meets that agency's requirements.**	**In the Stormwater Control Plan, note that all of the following restrictions apply to use the site:** ❑ **No person shall dispose of, nor permit the disposal, directly or indirectly of vehicle fluids, hazardous materials, or rinsewater from parts cleaning into storm drains.** ❑ **No vehicle fluid removal shall be performed outside a building, nor on asphalt or ground surfaces, whether inside or outside a building, except in such a manner as to ensure that any spilled fluid will be in an area of secondary containment. Leaking vehicle fluids shall be contained or drained from the vehicle immediately.** ❑ **No person shall leave unattended drip parts or other open containers containing vehicle fluid, unless such containers are in use or in an area of secondary containment.**

IF THESE SOURCES WILL BE ON THE PROJECT SITE …	… THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ L. **Fuel Dispensing Areas**	❑ **Fueling areas[1] shall have impermeable floors (i.e., portland cement concrete or equivalent smooth impervious surface) that are: a) graded at the minimum slope necessary to prevent ponding; and b) separated from the rest of the site by a grade break that prevents run-on of stormwater to the maximum extent practicable.** ❑ **Fueling areas shall be covered by a canopy that extends a minimum of ten feet in each direction from each pump. [Alternative: The fueling area must be covered and the cover's minimum dimensions must be equal to or greater than the area within the grade break or fuel dispensing area[1].] The canopy [or cover] shall not drain onto the fueling area.**		❑ **The property owner shall dry sweep the fueling area routinely.** ❑ **See the Business Guide Sheet, "Automotive Service—Service Stations" in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

[1] **The fueling area shall be defined as the area extending a minimum of 6.5 feet from the corner of each fuel dispenser or the length at which the hose and nozzle assembly may be operated plus a minimum of one foot, whichever is greater.**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
❑ M. **Loading Docks**	❑ **Show a preliminary design for the loading dock area, including roofing and drainage. Loading docks shall be covered and/or graded to minimize run-on to and runoff from the loading area. Roof downspouts shall be positioned to direct stormwater away from the loading area. Water from loading dock areas shall be drained to the sanitary sewer, or diverted and collected for ultimate discharge to the sanitary sewer.** ❑ **Loading dock areas draining directly to the sanitary sewer shall be equipped with a spill control valve or equivalent device, which shall be kept closed during periods of operation.** ❑ **Provide a roof overhang over the loading area or install door skirts (cowling) at each bay that enclose the end of the trailer.**		❑ **Move loaded and unloaded items indoors as soon as possible.** ❑ **See Fact Sheet SC-30, "Outdoor Loading and Unloading," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**
❑ N. **Fire Sprinkler Test Water**		❑ **Provide a means to drain fire sprinkler test water to the sanitary sewer.**	❑ **See the note in Fact Sheet SC-41, "Building and Grounds Maintenance," in the CASQA Stormwater Quality Handbooks at www.cabmphandbooks.com**

APPENDIX E—STORMWATER POLLUTANT SOURCES/SOURCE CONTROL CHECKLIST

IF THESE SOURCES WILL BE ON THE PROJECT SITE ...	... THEN YOUR STORMWATER CONTROL PLAN SHOULD INCLUDE THESE SOURCE CONTROL BMPs		
1 Potential Sources of Runoff Pollutants	2 Permanent Controls—Show on Stormwater Control Plan Drawings	3 Permanent Controls—List in Stormwater Control Plan Table and Narrative	4 Operational BMPs—Include in Stormwater Control Plan Table and Narrative
O. **Miscellaneous Drain or Wash Water** ❑ **Boiler drain lines** ❑ **Condensate drain lines** ❑ **Rooftop equipment** ❑ **Drainage sumps** ❑ **Roofing, gutters, and trim.**		❑ **Boiler drain lines shall be directly or indirectly connected to the sanitary sewer system and may not discharge to the storm drain system.** ❑ **Condensate drain lines may discharge to landscaped areas if the flow is small enough that runoff will not occur. Condensate drain lines may not discharge to the storm drain system.** ❑ **Rooftop mounted equipment with potential to produce pollutants shall be roofed and/or have secondary containment.** ❑ **Any drainage sumps on-site shall feature a sediment sump to reduce the quantity of sediment in pumped water.** ❑ **Avoid roofing, gutters, and trim made of copper or other unprotected metals that may leach into runoff.**	
❑ P. **Plazas, sidewalks, and parking lots.**			❑ **Plazas, sidewalks, and parking lots shall be swept regularly to prevent the accumulation of litter and debris. Debris from pressure washing shall be collected to prevent entry into the storm drain system. Washwater containing any cleaning agent or degreaser shall be collected and discharged to the sanitary sewer and not discharged to a storm drain.**

Appendix

F

Preparing Your Stormwater Control Operation & Maintenance Plan

How to prepare a customized Stormwater Control Operation & Maintenance Plan for the treatment and flow-control facilities (BMPs) on your site.

Stormwater treatment and flow-control facilities (BMPs) must be regularly maintained to ensure that they continue to be effective and that they do not cause flooding, harbor vectors, or otherwise create a nuisance.

Stormwater NPDES Permit Provision C.3.e requires each municipality verify that facilities are being adequately maintained. The Program reports the results of facility inspections to the Regional Water Quality Control Board (Water Board) annually.

This Appendix will assist you to prepare a customized Operation and Maintenance (O&M) Plan for your site.

Appendix F Contents

ICON KEY

- Helpful Tip
- Submittal Requirement
- Terms to Look Up
- References & Resources

Submit a draft O&M Plan with construction documents when you apply for permits to begin grading or construction on the site. Revise your draft O&M plan in response to any comments from your municipality, and incorporate new information and changes developed during project construction. Submit a revised, final O&M plan before construction is complete.

Your Final Stormwater Control O&M Plan must be submitted to and approved by your municipality before your building permit can be made final and a certificate of occupancy issued.

Local Requirements
Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A for local requirements, and see Appendix K for a description of the local BMP Operation and Maintenance Verification Program.

Your O&M Plan must be kept on-site for use by maintenance personnel and during site inspections. It is also recommended that a copy of the Stormwater Control Plan be kept onsite as a reference.

Verification Program Overview

Chapter Six describes a six-stage process for incorporating the treatment and flow-control facilities on your site into your municipality's stormwater facility operation and maintenance verification program. The stages are as follows:

1. Applicants for planning and zoning approval must confirm, in their Stormwater Control Plan, responsibility for operating and maintaining facilities until that responsibility is transferred.

2. The Stormwater Control Plan includes locations, types, and sizes of proposed treatment and flow-control facilities and general information about their operation and maintenance requirements.

3. Following approval of their planning and zoning application, applicants for building permits prepare a Stormwater Control Operation and Maintenance Plan. A draft O&M Plan must be submitted with the building permit application. A final O&M Plan must be submitted for review and approved by the municipality prior to building permit final and issuance of a certificate of occupancy.

4. Treatment and flow-control facilities must be maintained during site preparation and construction.

5. You must notify the municipality when responsibility for facility operation and maintenance is transferred to the property owner or occupant. Your municipality may require a Stormwater Management Facilities Operation and Maintenance Agreement. The standard agreement may also be found on the Program's web site. The

agreement runs with the land, and future property owners are obligated to implement its provisions.

6. Property owners must inspect and maintain facilities throughout the year—periodically and following storms—according to the schedule in their approved Stormwater Control Operation and Maintenance Plan.

► ANNUAL CERTIFICATE OF COMPLIANCE

The NPDES permit requires municipalities to inspect a subset of prioritized treatment measures each year. Municipalities may require that property owners (or their lessees) obtain an annual certificate of compliance certifying appropriate operation and maintenance of treatment and flow-control facilities on their site.

To obtain a certificate of compliance, the responsible party must request and pay for an inspection from the municipality each year. The municipality will inspect the property and may:

1. Issue a certificate,

2. Issue a conditional certificate requiring correction of noted deficiencies by a specific date, or

3. Deny the certificate.

Alternatively, owners (or lessees) may arrange for inspection by a private company authorized by the municipality.

See Chapter Six for a detailed description of the process for planning operation and maintenance of treatment and flow-control facilities.

Local Requirements

Cities, towns, or the County may have requirements that differ from, or are in addition to, this countywide Guidebook. See Appendix A for local requirements, and see Appendix K for a description of the local BMP Operation and Maintenance Verification Program.

Stormwater Control O&M Plan Overview

► PURPOSES AND USERS

Your Stormwater Control O&M Plan should:

- Document the design parameters, features, methods and materials of construction, intended mode of operation, and other key characteristics of stormwater treatment and flow-control facilities on your site.

- Set forth a detailed maintenance program and schedule to ensure that facilities continue to operate as intended.

- Anticipate potential problems or failures and provide instructions for troubleshooting.

- Provide a reference and checklists to be used during verification inspections.

The primary audience for your O&M Plan is facility maintenance staff, including those responsible for supervising landscape and/or mechanical maintenance. The focus should be on creating easy-to-follow step-by-step instructions for implementing and documenting maintenance activities.

The secondary audience is municipal staff, Water Board staff, and others who may be responsible for verifying maintenance.

► CONTENTS

Your O&M Plan should follow this general outline:

I. Inspection and Maintenance Log (Attachment F-2)

II. Updates, Revisions and Errata

III. Introduction

- A. Narrative overview describing the site; drainage areas, routing, and discharge points; and treatment and flow-control facilities

IV. Responsibility for Maintenance

- A. General
    - (1) Name and contact information for responsible individual(s).
    - (2) Organization chart or charts showing organization of the maintenance function and location within the overall organization.
    - (3) Reference to Operation and Maintenance Agreement (if any). A copy of the agreement should be attached.
    - (4) Maintenance Funding
        - (a) Sources of funds for maintenance
        - (b) Budget category or line item
        - (c) Description of procedure and process for ensuring adequate funding for maintenance
- B. Staff Training Program
- C. Records
- D. Safety

V. Summary of Drainage Areas and Treatment/Flow-Control Facilities

A. Drainage Areas

(1) Drawings showing pervious and impervious areas (copied or adapted from Stormwater Control Plan)

(2) Designation and description of each drainage area and how flow is routed to the corresponding facility.

B. Treatment and Flow-Control Facilities

(1) Drawings showing location and type of each facility

(2) General description of each facility (Consider a table if more than two facilities)

(a) Area drained and routing of discharge.

(b) Facility type and size

VI. Document Design of Treatment and Flow-Control Facilities

A. "As-built" drawings of each facility (design drawings in the draft Plan)

B. Manufacturer's data, manuals, and maintenance requirements for pumps, mechanical or electrical equipment, and proprietary facilities (include a "placeholder" in the draft plan for information not yet available).

C. Specific operation and maintenance concerns and troubleshooting

VII. Facility Maintenance Schedule

A. Summary Annual Maintenance Schedule for All Facilities (combined)

B. Inspection and Maintenance Schedule for Each Facility (see Step 4 below), including checklists for:

(1) Routine inspection and maintenance

(2) Annual inspection and maintenance

(3) Inspection and maintenance after major storms

C. Service Agreement Information

Tools and Assistance

The following step-by-step instructions and attached forms will help you prepare your Stormwater Control Operation and Maintenance Plan. You may use, adapt, and assemble these documents to prepare your own Plan which will be customized to the specific needs of your site.

These include:

- A standard "Stormwater Management Facilities Operation and Maintenance Agreement" (available on the CCCWP C.3 web page at www.cccleanwater.org/construction/nd.php).
- A form for stating or updating key contact information (Attachment 1).
- An example Inspection and Maintenance Log (Attachment 2).
- A format for an independent inspector's annual inspection report (Attachment 3).
- O&M Fact Sheets, developed by the California Stormwater Quality Association for 15 Treatment BMPs (available in the Municipal Handbook at www.cabmphandbooks.org) and O&M Fact Sheets for 6 additional Treatment BMPs developed by the Santa Clara Valley Urban Runoff Pollution Prevention Program (www.scvurppp.org).
- Additional useful references, including links to additional documents available on the web (in the bibliography).

Step by Step

The following step-by-step guidance will help you prepare each required section of your Stormwater Control Operation and Maintenance Plan.

Preparation of the plan will require familiarity with your treatment and flow-control facilities as they have been constructed and a fair amount of "thinking through" plans for their operation and maintenance. The text and forms provided here will assist you, but are no substitute for thoughtful planning.

1: Responsible Individuals

► DESIGNATE RESPONSIBLE INDIVIDUALS

To begin creating your O&M Plan, your organization must designate and identify:

- The individual who will have direct responsibility for the maintenance of stormwater controls. This individual should be the designated contact with municipal inspectors and should sign self-inspection reports and any correspondence with the municipality regarding verification inspections.
- Employees or contractors who will report to the designated contact and are responsible for carrying out facility operation and maintenance.
- The corporate officer authorized to negotiate and execute any contracts that might be necessary for future changes to operation and maintenance or to implement remedial measures if problems occur.
- Your designated respondent to problems, such as clogged drains or broken irrigation mains, that would require immediate response should they occur during off-hours.

► LIST CONTACT INFORMATION

List the contact information for each designee on the form provided (Attachment 1). Include this form directly in Section 2 of your O&M Plan.

Updated contact information must be provided to the municipality immediately whenever a property is sold and whenever designated individuals or contractors change.

Complete a new Attachment 1 and add it to Section 1—and mail or fax a copy to the municipality—whenever this occurs.

► ORGANIZATION CHART

Draw or sketch an organization chart to show the relationships of authority and responsibility between the individuals responsible for O&M. This need not be elaborate, particularly for smaller organizations.

► FUNDING FOR OPERATION AND MAINTENANCE

Describe how funding for facility operation and maintenance will be assured, including sources of funds, budget category for expenditures, process for establishing the annual maintenance budget, and process for obtaining authority should unexpected expenditures for major corrective maintenance be required.

► STAFF OR CONTRACTOR TRAINING

Describe how your organization will accommodate initial training of staff or contractors regarding the purpose, mode of operation, and maintenance requirements for the facilities on your site. Also, describe how your organization will ensure ongoing training as needed and in response to staff changes.

2: Summarize Drainage and Stormwater Facilities

Your Stormwater Control Plan, prepared and submitted with the planning and zoning application for your project, contains information that will be needed for maintenance or future renovation of the facilities on your site.

Incorporate the following into your O&M Plan:

- Figures delineating and designating pervious and impervious areas.
- Figures showing locations of treatment and flow-control facilities on the site.
- Tables of pervious and impervious areas served by each facility.

Review the Stormwater Control Plan narrative that describes each facility and its tributary drainage area and update the text to incorporate any changes that may have occurred during planning and zoning review, building permit review, or construction. Incorporate the updated text into your O&M Plan.

3: Document Facilities "As Built"

Include the following information from final construction drawings:

- Plans, elevations, and details of all facilities. Annotate if necessary with designations used in the Stormwater Control Plan.
- Design information or calculations submitted in the detailed design phase (i.e., not included in the Stormwater Control Plan)
- Specifications of construction for facilities, including sand or soil, compaction, pipe materials and bedding.

In the final O&M Plan, note field changes to design drawings, including changes to any of the following:

- Location and layouts of inflow piping, flow splitter boxes, and piping to off-site discharge
- Depths and layering of soil, sand, or gravel
- Placement of filter fabric or geotextiles
- Changes or substitutions in soil or other materials.
- Natural soils encountered (e.g. sand or clay lenses)

4: Prepare Customized Maintenance Plans

Prepare a maintenance plan, schedule, and inspection checklists (routine, annual, and after major storms) for each facility. Plans and schedules for two or more similar BMPs on the same site may be combined.

Use the following resources to prepare your customized maintenance plan, schedule, and checklists.

- Specific information noted in Steps 2 and 3, above.
- Other input from the facility designer, municipal staff, or other sources.
- BMP Operation and Maintenance Fact Sheets.

Note any particular characteristics or circumstances that could require attention in the future, and include any troubleshooting advice.

Also include manufacturer's data, operating manuals, and maintenance requirements for any:

- Pumps or other mechanical equipment.
- Proprietary devices used as stormwater treatment or flow-control facilities.

Manufacturers' publications should be referenced in the text (including models and serial numbers where available). Copies of the manufacturers' publications should be included as an attachment in the back of your O&M Plan or as a separate document.

5: Compile O&M Plan

Assemble and make copies of your O&M Plan. One copy must be submitted to the municipality, and at least one copy kept on-site. Here are some suggestions for formatting the O&M Plan:

- Format plans to 8½" x 11" to facilitate duplication, filing, and handling.
- Include the revision date in the footer on each page.
- Scan graphics and incorporate with text into a single electronic file. Keep the electronic file backed-up so that copies of the O&M Plan can be made if the hard-copy is lost or damaged.

6: Updates

Your Stormwater Control Operation and Maintenance Plan will be a living document.

Operation and maintenance personnel may change; mechanical equipment may be replaced, and additional maintenance procedures may be needed. Throughout these changes, the O&M Plan must be kept up-to-date.

Updates may be transmitted to your municipality at any time. However, at a minimum, updates to the O&M Plan must accompany the annual inspection report. These updates should be placed in reverse chronological order (most recent at the top) in Section 1 of the binder. If the entire O&M Plan is updated, as it should be from time to time, these updates should be removed from the first section, but may be filed (perhaps in the back of the binder) for possible future reference.

References and Resources

- RWQCB Order R2-2003-0022, Provision C.3.e
- *C.3 Stormwater Handbook: Guidance for Implementing Stormwater Requirements for New and Redevelopment Projects, Final Draft, June 2004*. Santa Clara Valley Urban Runoff Pollution Prevention Program.
- *Start at the Source* (BASMAA, 1999) pp. 139-145.
- *Urban Runoff Quality Management* (WEF/ASCE, 1998). pp 186-189.
- *Stormwater Management Manual* (Portland, 2004). Chapter 3.
- *California Storm Water Best Management Practice Handbooks* (CASQA, 2003) Fact Sheets
  Bioretention
  Drain Insert
  Extended Detention Basin
  Infiltration Basin
  Infiltration Trench
  Multiple Systems
  Media Filter (TC40)
  Media Filter (MP40)
  Retention/Irrigation
  Vegetated Buffer Strip
  Vegetated Swale
  Vortex Separator
  Water Quality Inlet
  Wet Pond
  Wet Vault
  Wetland
- SCVURPPP Operation & Maintenance Fact Sheets:
  Exfiltration Trench
  Hydrodynamic Separators
  Planter Boxes
  Porous Pavement
  Roof Gardens
  Underground Detention Systems
- Best Management Practices Guide (Public Telecommunications Center for Hampton Roads, 2002).
- Georgia Stormwater Manual Structural Control Maintenance Checklists. Atlanta Regional Commission, 2001. www.georgiastormwater.com
- Operation, Maintenance and Management of Stormwater Management (Watershed Management Institute, 1997). Order from the Center for Watershed Protection.

Designation of Individuals Responsible for Stormwater Treatment BMP Operation and Maintenance	
Date Completed	
Facility Name	
Facility Address	
Designated Contact for Operation and Maintenance	
Name:	Title or Position:
Telephone:	Alternate Telephone:
Email:	
Off-Hours or Emergency Contact	
Name:	Title or Position:
Telephone:	Alternate Telephone:
Email:	
Corporate Officer (authorized to execute contracts with the City, Town, or County)	
Name:	Title or Position:
Address:	
Telephone:	Alternate Telephone:
Email:	

Stormwater BMP Inspection and Maintenance Log

Facility Name	
Address	
Begin Date	End Date

Date	BMP ID#	BMP Description	Inspected by:	Cause for Inspection	Exceptions Noted	Comments and Actions Taken

Instructions: Record all inspections and maintenance for all treatment BMPs on this form. Use additional log sheets and/or attach extended comments or documentation as necessary. Submit a copy of the completed log with the annual independent inspectors' report to the municipality, and start a new log at that time.

- BMP ID# — Always use ID# from the Operation and Maintenance Manual.
- Inspected by — Note all inspections and maintenance on this form, including the required independent annual inspection.
- Cause for inspection — Note if the inspection is routine, pre-rainy-season, post-storm, annual, or in response to a noted problem or complaint.
- Exceptions noted — Note any condition that requires correction or indicates a need for maintenance.
- Comments and actions taken — Describe any maintenance done and need for follow-up.

Sample Contents of Inspector's Report

I. General

A. Date and time of site visit
B. Reason for inspection (e.g., routine/annual, follow-up, by municipality request, or response to complaint)
C. Weather/rainfall
D. Personnel participating
E. Ability to obtain access to the site

II. Review of Stormwater Control Operation and Maintenance Plan

A. Ability to obtain and review on-site copy of plan
B. Date of last update to plan
C. Sections out-of-date and updates needed
  (1) Contact information for site personnel
  (2) Information on BMPs
  (3) Records of previous inspections
D. Review of maintenance logs
  (1) Comparison to maintenance schedule. Note exceptions.

III. Results of Site Inspection

A. Overall condition of site and any exceptional circumstances (e.g., construction in progress, flooding)
B. For each BMP listed in the Stormwater Control Operation and Maintenance Plan
  (1) Items inspected
  (2) Exceptions noted
  (3) Corrective actions needed
    (a) Exceptions not affecting BMP performance (correct and re-inspect in one year)
    (b) Exceptions affecting BMP performance (correct and re-inspect immediately)

IV. Compliance Status

A. In compliance—no corrective actions required, or
B. In compliance—implement corrective actions and re-inspect in one year, or
C. Not in compliance—implement corrective actions and re-inspect

V. Summary and Recommendations

A. Note any required follow-up and schedule re-inspection if necessary

Appendix

G

Example Stormwater Control Plans

Stormwater Control Plans that illustrate the instructions in the Stormwater C.3 Guidebook

Examples are posted at www.cccleanwater.org/construction/nd.php. New examples are posted from time to time.

Appendix

H

Contra Costa Hydrology Data

See instructions in Chapter Five.

Appendix H consists of two graphical design aids:

1. Contra Costa County Flood Control and Water Conservation District (CCCFCWCD) Drawing B-166, "Mean Seasonal Isohyets Compiled from Precipitation Records 1879-1973." The 11" x 17" drawing is not reproduced here in the *Guidebook*, but may be downloaded in Adobe Acrobat format from the Program's C.3 web page at www.cccleanwater.org/construction/nd.php. Printed copies are available from the Contra Costa County Public Works Department.

2. "Unit Basin Storage Size for 80% Capture." Technical background is in the memorandum, "Rainfall Data Analysis and Guidance for Sizing Treatment BMPs" (Geosyntec Consultants, 2005), available on the Program's C.3 web page.

Appendix I

Integrated Management Practices Sizing Tool

See the instructions in Chapter Five.

The tool, operating requirements, and help files may be downloaded from the Program's C.3 web page at www.cccleanwater.org/construction/nd.php.

Appendix

J

Example BMP Operation & Maintenance Plans

Check www.cccleanwater.org/construction/nd.php for updates.

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Appendix

K

Local BMP Operation & Maintenance Verification Program

Information on how your local municipality documents, inspects, and verifies maintenance for stormwater treatment BMPs. See Chapter Six. Request from your municipal planning department.

The Contra Costa Clean Water Program C.3 web page includes links to each Contra Costa municipality's C.3 information.